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Workshop Chairman: Charles L. Bretschneider
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University of Hawaii

Surf Parameters
by James Walker

Summary of Beach Parameters Study
by J. Battjes

Alienation and the Environment:
A Social Parameter
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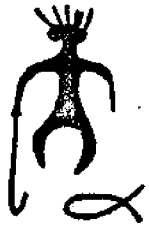

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SURF PARAMETERS

by

James R. Walker, P.E., Ph.D.*

Introduction

Recreational surfing has been studied in Hawaii to develop criteria for the preservation, enhancement, and design of surf sites. A three-year study of surf parameters was conducted by the Department of Ocean Engineering, University of Hawaii. Two reports were written in 1974 summarizing the work conducted. One was written by Kelly (1974) describing the social aspects of surfing, and the other was written by Walker (1974) describing the physical parameters. This paper summarizes the results of the study of physical parameters. Methods included field studies, analytic studies, and hydraulic model studies to describe the characteristics of surf shoals and of surfing waves. Field studies were conducted to observe the interactions between waves with bathymetry, wind with waves, and surfers with waves. Hydraulic model studies were conducted to study in detail the interaction of waves over a general surf shoal configuration. Comparisons of analytical methods with the results of the field observations and model studies were made to evaluate the applicability of analytic methods in describing surfing phenomena. An example of preservation of a surf site is presented to demonstrate an application of the study results. Concepts for design of a surf site are summarized.

Methods

Field studies were conducted at several surf sites in the Hawaiian Islands. Primary study sites located on the Island of Oahu included Queens, Ala Moana reef sites, Makaha, Waimea Bay, Pipeline, and Sunset. Detailed bathymetric charts were constructed or were available at each of these prime surf sites. The

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interactions of the surfer with the wave relative to the bathymetry at these surf sites were studied by plotting the position of the surfers relative to the bathymetry. The positions of the surfers were measured by triangulation methods using specially modified transits which recorded the angle between a baseline and a surfer. By taking time-lapsed recordings, the paths of surfers and their average velocities between successive readings were determined. Aerial photographs taken at timed intervals from a vertical position were superimposed over the bathymetry of the surf sites. The positions and velocities of the surfers were determined by these methods. The interactions of the waves with the bathymetry were also studied by this method by plotting the wave crests as they propogate over the bathymetry. During the conduct of the study, estimates of wave heights and periods were required. Wave heights were estimated visually. Calibration of visual observations was made by photographic means. A photograph was taken with a telescopic lense a known distance from the wave. The wave height was estimated by both trigonometric concepts and by measuring the relative size of the wave to surfer. The results of the calibration indicated that the typical surfer underestimates wave heights over 6 feet in height by a factor from 50 to 100 percent.

Two hydraulic model studies were conducted. The first was a preliminary study which investigated wave transformations over shoals of varying dimensions. The size of shoal features, channel widths, alignments, etc., were studied and qualitative observations were made to establish some basic requirements to aid in field observations. A more detailed model was conducted in a specially built wave tank. Measurements were made of wave height growth in shoaling water and of celerity as the wave propogated from deep water through the breaking region in shallow water. The wave transformations over a three-dimensional surf shoal were investigated to aid in developing design criteria for an artificial surf shoal.

Characteristics of a Surfing Site

Surfing waves vary considerably in form from location to location and from hour to hour. Each surf site has it own characteristics with no two sites being exactly alike. The general form of a surf site and its characteristics are summarized below to develop the basic concepts. It should be recognized that surfers will surf what waves are available to them. A small, locally wind-generated wave may be acceptable for a young beginning surfer on the windward coast; however, it might not be acceptable to a more experienced surfer with adequate means of transportation.

The surfing wave generally is a breaking wave. Figure 1 is a schematic showing the properties of the breaking wave. The surfer maneuvers in the region called the peel or curl. The peel is the region of the breaking wave which transitions from the broken to unbroken portion of the wave. As the wave propogates toward shore, the peel region moves laterally relative to the wave crest. The angle subtended between the unbroken wave crest and the breaker position at two successive times is called the peel angle. The peel angle concept is shown schematically in Figure 2. The peel angle is a measure of how fast the surfer must travel across the wave in order to successfully ride the wave. Waves breaking with peel angles of 90^{o} break along an orthogonal. The surfer may ride straight into shore. This type of wave is most suitable for a beginning surfer who has not developed skill levels sufficient to negotiate a turn. A peel angle of 0 degrees indicates that the wave breaks simultaneously along the entire crest length. In surfing vernacular, this condition is called a "close out". This condition is not conducive to surfing. The peel angle varies as the wave propogates toward shore. Small sections of "close-out" waves may produce desirable surfing conditions. Table 1 summarizes results of field investigations where wave parameters, including peel angle, were measured. Peel angles from Table 1 are plotted in Figure 3 as a function of breaking wave height. The observations indicate the region where waves are surfable. A peel angle of 30^{o} is suggested as a minimum for a plunging breaker at 6-foot height. For waves of greater height, the minimum peel angle is increased. This is due to the greater celerity of the wave for larger breakers. The maximum surfer velocity appears to be on the order of 40 feet per second. The data points 7a and 8a taken at Pipeline and Sunset, respectively, were taken under conditions considered by surfers to not be conducive to surfing, since the waves were essentially "closing out".

Waves with heights less than about 6 feet may be ridden in the white water region. The peel angle is not as stringent a criterion to describe surfing conditions as for waves with greater heights. The minimum surfable peel angle increases with a decrease in wave height. The minimum peel is not precisely defined since it is very dependent upon wave steepness and surfer ability. Obtuse peel angles are also surfed for some sections, such as after Makaha Bowl breaks.

The emphasis in the preceding discussion has been focused on the peel angle. Breaker height and breaker form are, perhaps, the two most obvious parameters which require only brief discussion. Breaker height is one of the most important factors determining the desirability of a surf site. Waves are surfed with heights from one to over 30 feet. The greater the height, the more skill that is required for the surfer to ride the wave. This is illustrated in Figure 3 by subjectively developed cri-

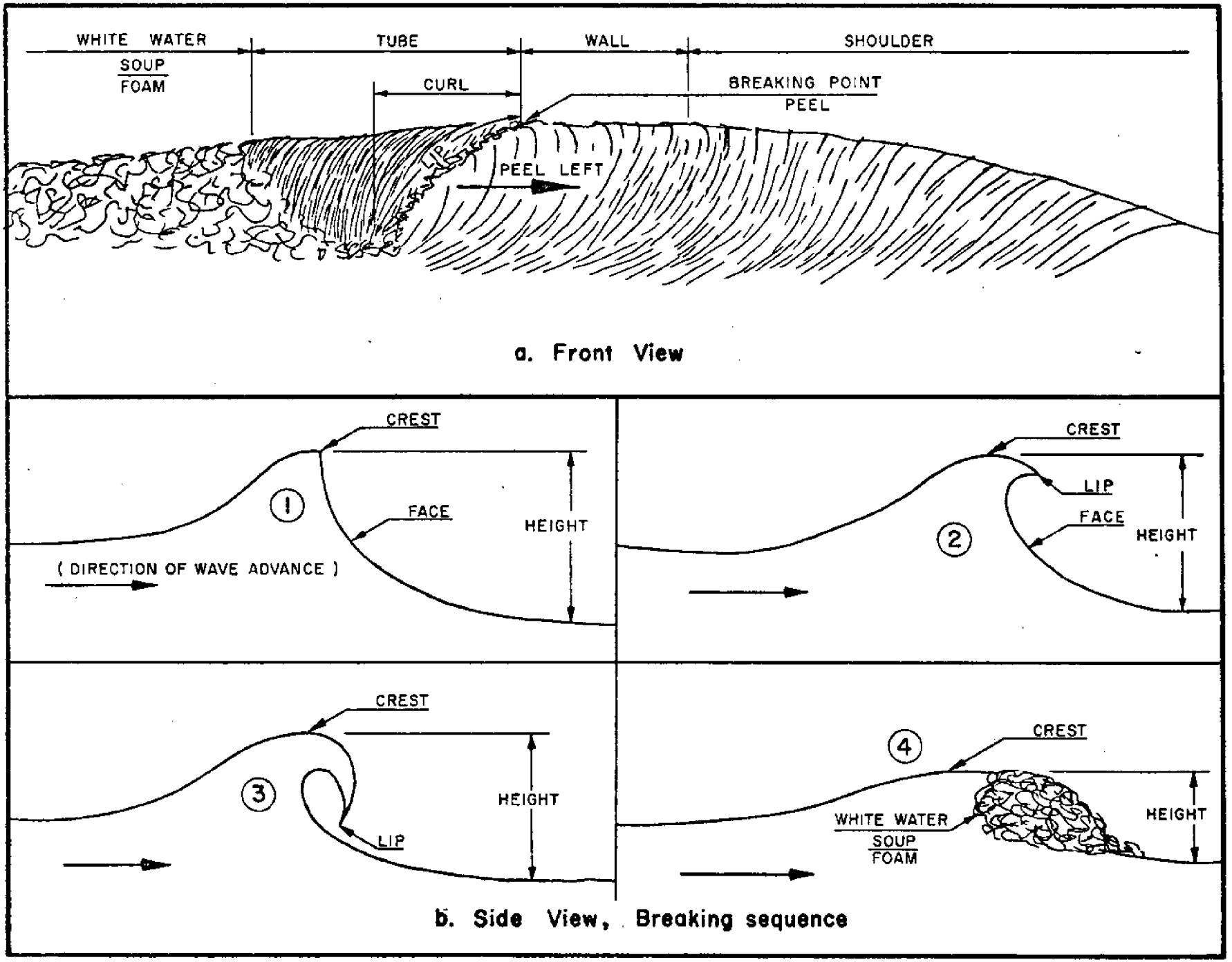
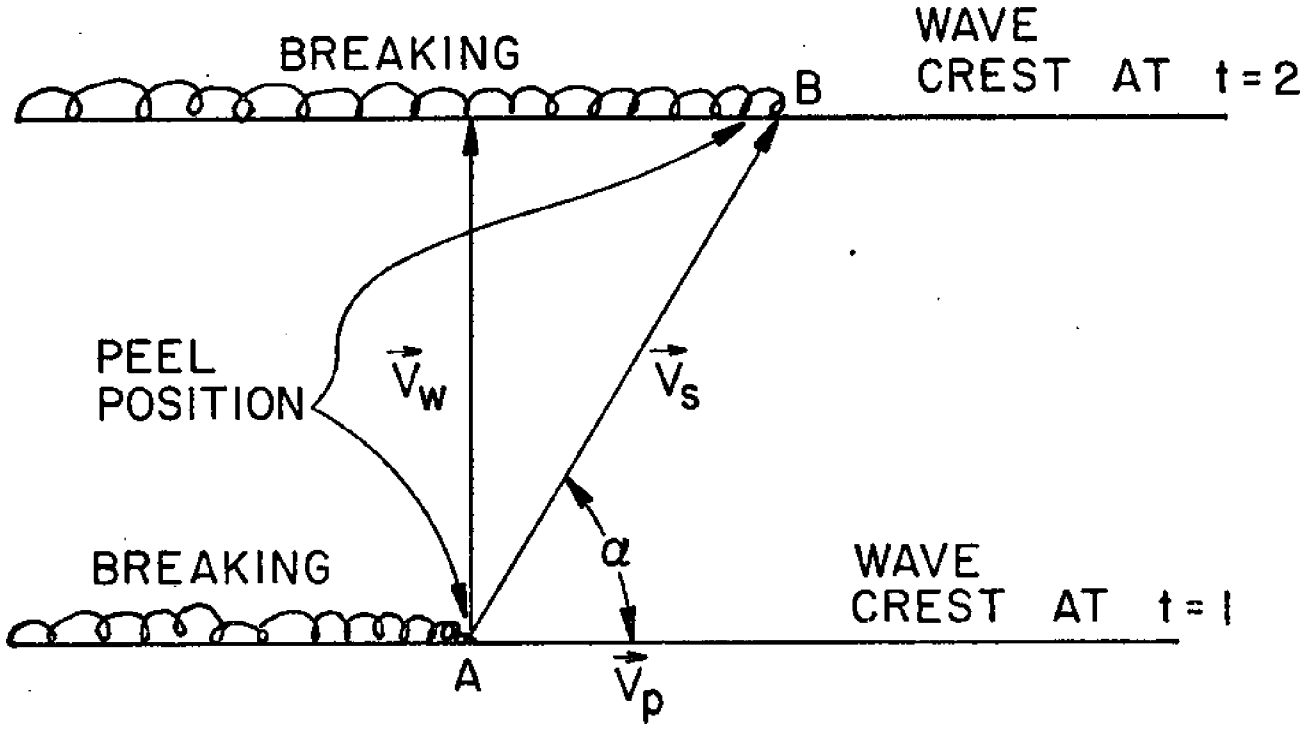


Figure 1 : Surfing Wave Terms



$\vec{V}_w$ = VELOCITY OF WAVE

$\vec{V}_s$ = SURFER VELOCITY

$\vec{V}_p$ = PEEL VELOCITY

α = PEEL ANGLE

FIG. 2 : Peel Parameters

Table 1: SURF SITE OBSERVATIONS

Data Pt	Site	Bottom Slope S	Breaker Height H_b (ft)	Wave Period T(sec)	Breaker Type Index	Surfer Velocity V_s (ft/sec)	Peel Angle α (degrees)	Breaker Type	Date
1a	Queen's	40	4	12	0.035	18	60R	Spill	3-16-71
b	Queen's	40	7	20	0.022	22	65R	Spill-Plunge	4-26-72
c	Queen's	40	6	20	0.019	21	55R	Spill-Plunge	4-26-72
d	Queen's	40	6	20	0.019	18	80L	Spill-Plunge	4-26-72
2a	Ala Moana	33	6	17	0.021	30	35	Plunge	
b	Ala Moana	20	10	20	0.015	30	38	Plunge	
c	Ala Moana	25	9	20	0.017	30	32	Plunge	
3a	Lefts	30	6	20	0.014	30	45	Plunge	
4a	Kewalo	37	6	17	0.024	18	65	Plunge-Spill	
5a	Makaha	60	6	14	0.057	28	65	Spill	
b	Makaha	60	8	16	0.058	20	68	Spill	
6a	Waimea	20	17	16	0.041	38	80	Plunge-Spill	
7a	Pipeline	65	18	16	0.14	45*	35	Plunge	
b	Pipeline	22	12	16	0.032	32	40	Hard Plunge	
8a	Sunset	100	18	16	0.22	43*	40	Plunge-Spill	
b	Sunset	100	15	16	0.18	33	65	Plunge-Spill	
9a	Canoes	34	6	20	0.016		45R	Spill-Plunge	4-26-72
b	Canoes	34	6	20	0.016		40R	Spill-Plunge	4-26-72

* Wave not ridden, R = ride to the right, L = ride to the left

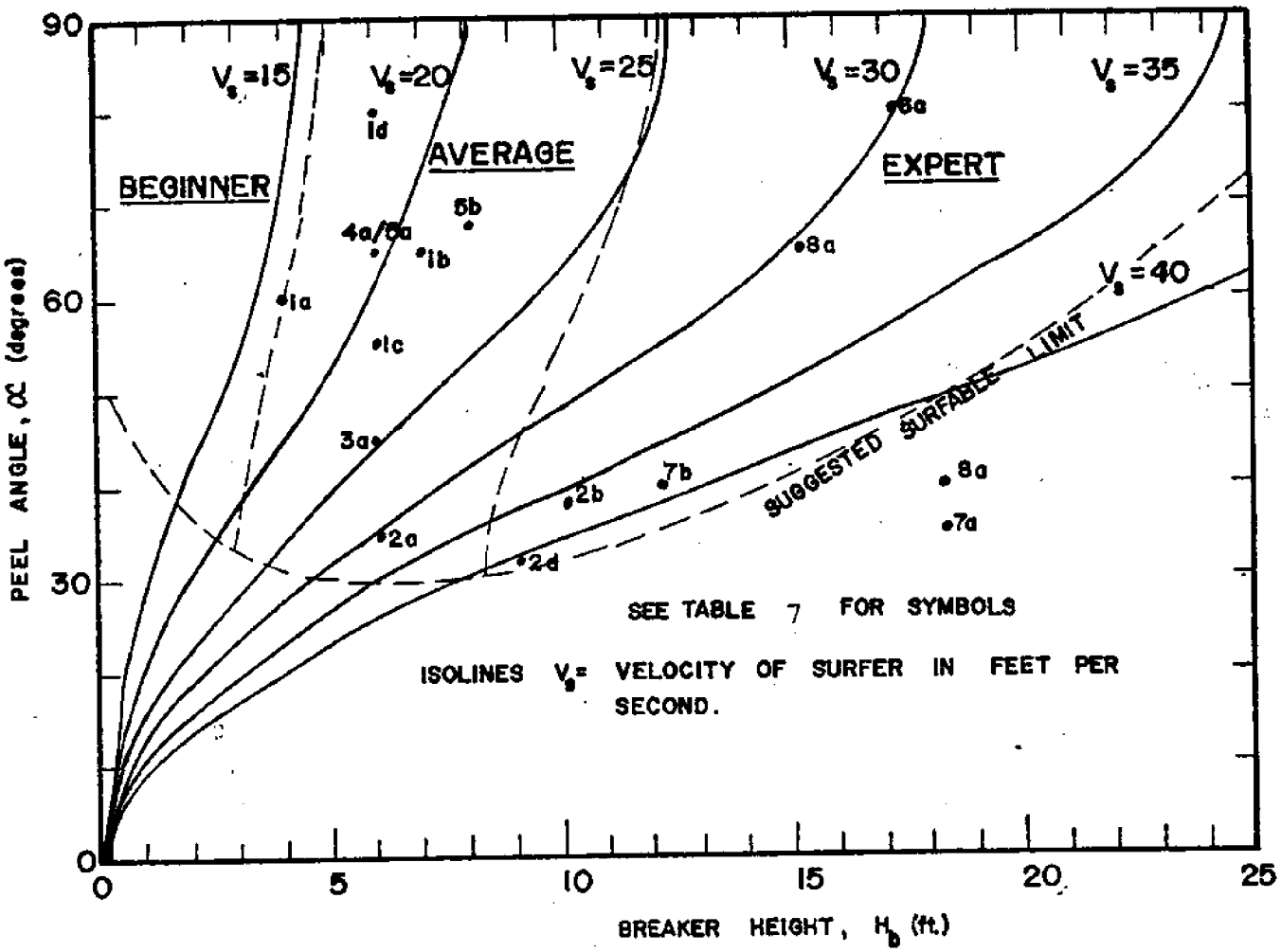


FIGURE 3: PEEL ANGLE vs. BREAKER HEIGHT

teria. Beginning surfers prefer wave heights less than 5 feet and greater peel angles. As the surfer gains more confidence and control, he rides the faster waves with greater heights and smaller peel angles. Twelve feet is a subjective evaluation dividing surfers with intermediate skill levels and those of advanced or expert skill levels.

Breaker-type is a description of the form in which the wave cross-section breaks. Surfers tend to ride waves of the spilling to plunging breaker-type. Surging and collapsing types are generally not surfed. Expert surfers prefer the plunging type, since this usually presents the greatest challenge. Surfers may ride under the white water on the spilling-type or partial plunging-type.

The breaking properties of a wave are controlled by the interaction of the incident wave with the bottom. The breaking wave height is a function of the incident wave steepness, H_o/L_o, and bottom slope, S. Figure 4 illustrates an emperically-derived wave shoaling nomogram developed over a 1:30 slope in the hydraulic model study. The wave height amplification as a function of relative depth for given wave steepness is illustrated by this figure. The lower steepness waves amplify to a significantly greater height than predicted by application of Airy theory and the principal of conservation of energy flux. The range of surfing conditions in Hawaii is generally in the lower wave steepness range. Criteria developed for design of coastal structures and experimental data are generally limited to the higher values of wave steepness. The wave height amplification factor at breaking varies as a function of H_o/L_o and S, according to the emperical equation (Koh and Le Méhauté, 1966):

$$\frac{H_b}{H_o} = .76S^{1/7}\left(\frac{H_o}{L_o}\right)^{-1/4} \quad \text{for} \quad \begin{array}{l} 1/50 \leq S \leq 1/5; \\ 0.002 \leq \frac{H_o}{L_o} \leq 0.09 \end{array}$$

The steeper the slope, the greater a given incident wave height at breaking. The breaker height of a surfing wave is controlled by the depth of water and bottom slope. A wave breaks when its height is from about .7 to 1.2 times the bottom depth. The wave height is greater relative to the depth for steeper bottom slopes.

Profiles taken through prime surf sites are shown in Figure 5. Each of these prime surf sites has a totally different composite slope, which accounts to a great deal the vast differences in the characteristics of the sites. Makaha has a very gentle slope to the 20-foot depth. This flat slope accounts for the spilling-type breaker which breaks under a wide variety of wave conditions. Makaha has one of the largest site capacities, since the breaking area is diffused over a large area. Waimea Bay has a similar configuration; however, the shelf is at a greater depth.

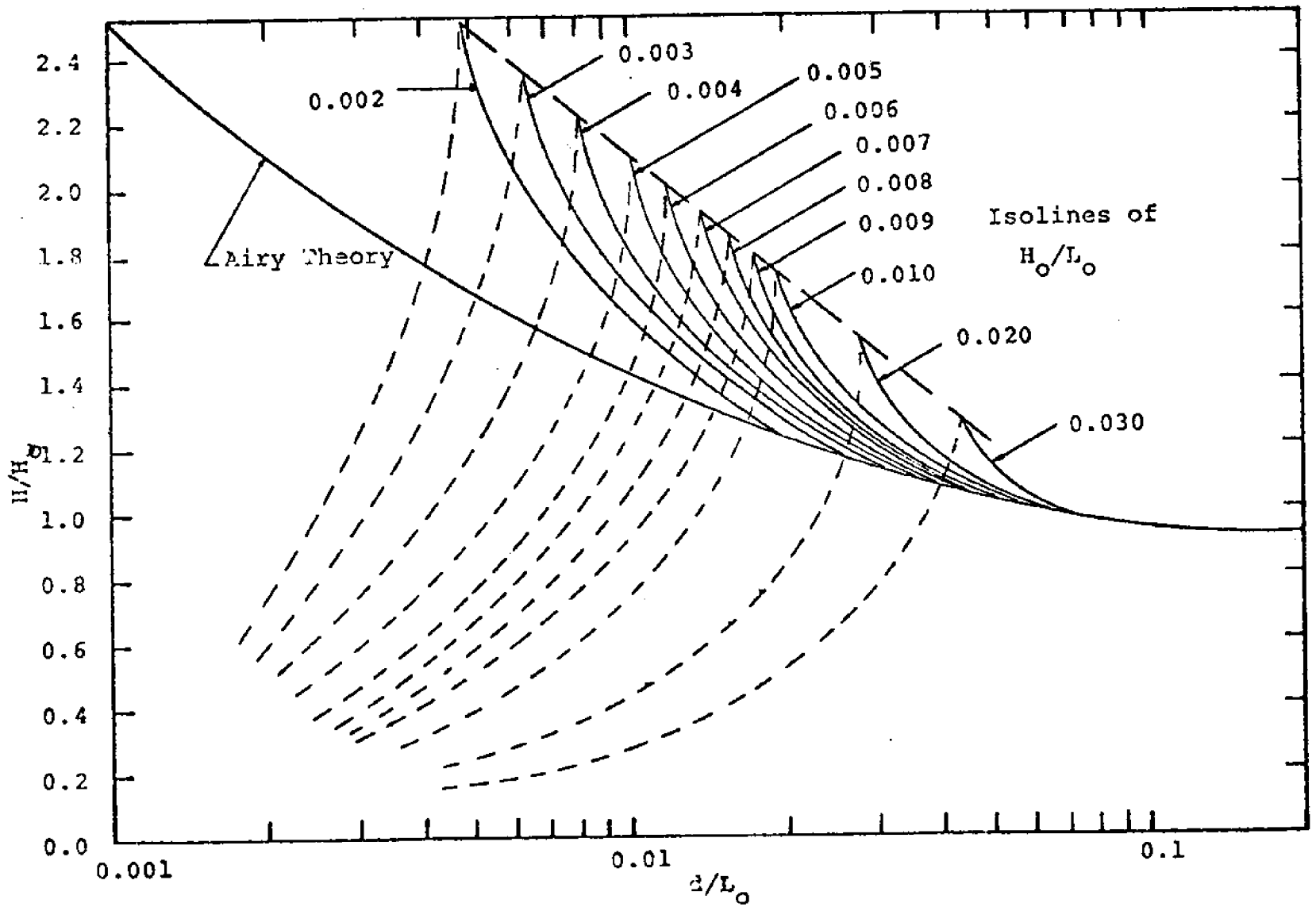


Figure 4: Wave Shoaling

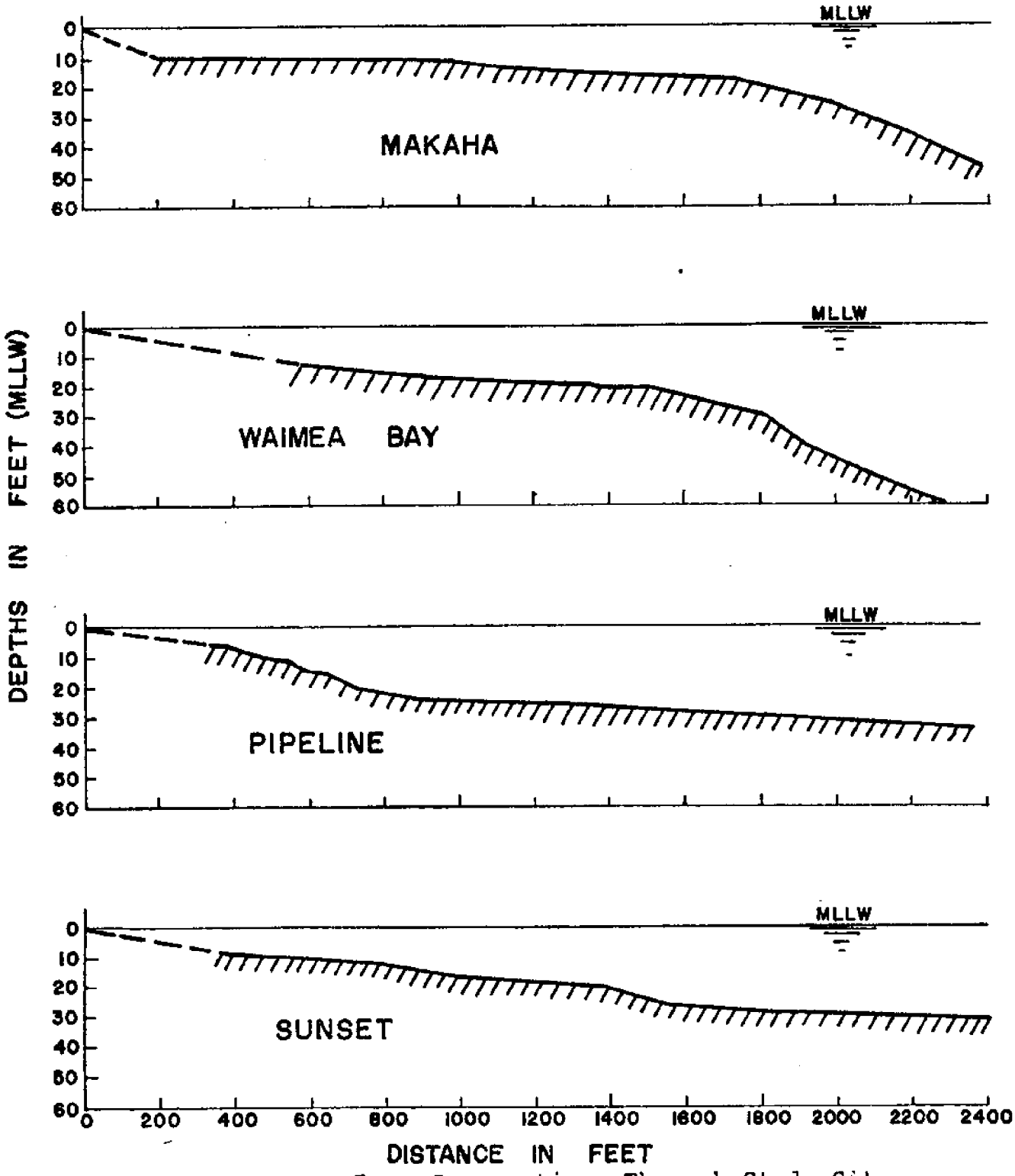


FIGURE 5: Crossections Through Study Sites

A minimum wave height of 15 feet breaks in the surfing area at Waimea. Smaller waves do not break until they reach shore in a surge or collapsing breaker. Waves higher than 15 feet break in relatively the same location due to the steep offshore slope, compared to Makaha. Pipeline has a gentle offshore slope and a steep nearshore slope. This produces a well-confined surf area for waves under 15 feet. Larger waves tend to break in a less well-defined area in a more spilling form. Sunset breaks in a spilling, plunging type over a wide range of conditions, but is limited in height as indicated by the flat offshore bathymetry.

The bathymetry of some south shore surf sites is shown in Figure 6. Queens and Big Lefts are shown to have a small trench located on the shoreward side of the shoal. The trench has the important effect of transforming the breaking wave to a non-breaking wave. This limits the shoreward transport of the surfboard, thereby isolating the surf site from the beach. This is an important concept for development of an artificial surf site which must be compatible with swimming or which is located near a coastal structure or rocky shoreline. Tennis courts, Ala Moana, and Sharkhole have a flat reef extending several hundred feet shoreward from the riding area. The wave continues to break for several hundred feet over the reef flat transporting loose boards a good distance from the surf riding area. Big Lefts has a minimum depth of 6 feet. Waves less than 5 feet in height do not break over the shoal.

The bottom configuration in plan view controls the peel angle as a result of the dependency of the breaker height on bottom depth. Figure 7 shows the path of a surfer and wave crests propogating over Queens surf shoal. The shoal is 300 feet wide and 600 feet long. A 150-foot wide, 7-foot deep, sand-filled channel is located on the left side and a large 16-foot deep hole on the right side. The shoal is located at the head of a bay which has an average 1:120 slope from the 12- to 45-foot depths. The slope steepens to 1:40 from the 12- to 6-foot depths. The 1:40 slope induces incident waves to break in a plunging to spilling form. The depth differential between the channel and shoal causes the wave to break along the bottom contours, producing peel patterns to the left and right sides of the shoal.

Influence of the Wind on Surfing Conditions

Observations of and experience gained at surf sites indicate that the wind is a primary factor which influences the quality of surfing conditions. Figure 8 schematically shows the influence of wind on a breaking wave. A component of wind opposing the direction of the wave propogation tends to retard the breaking process, thus allowing the wave to become steeper and attain a

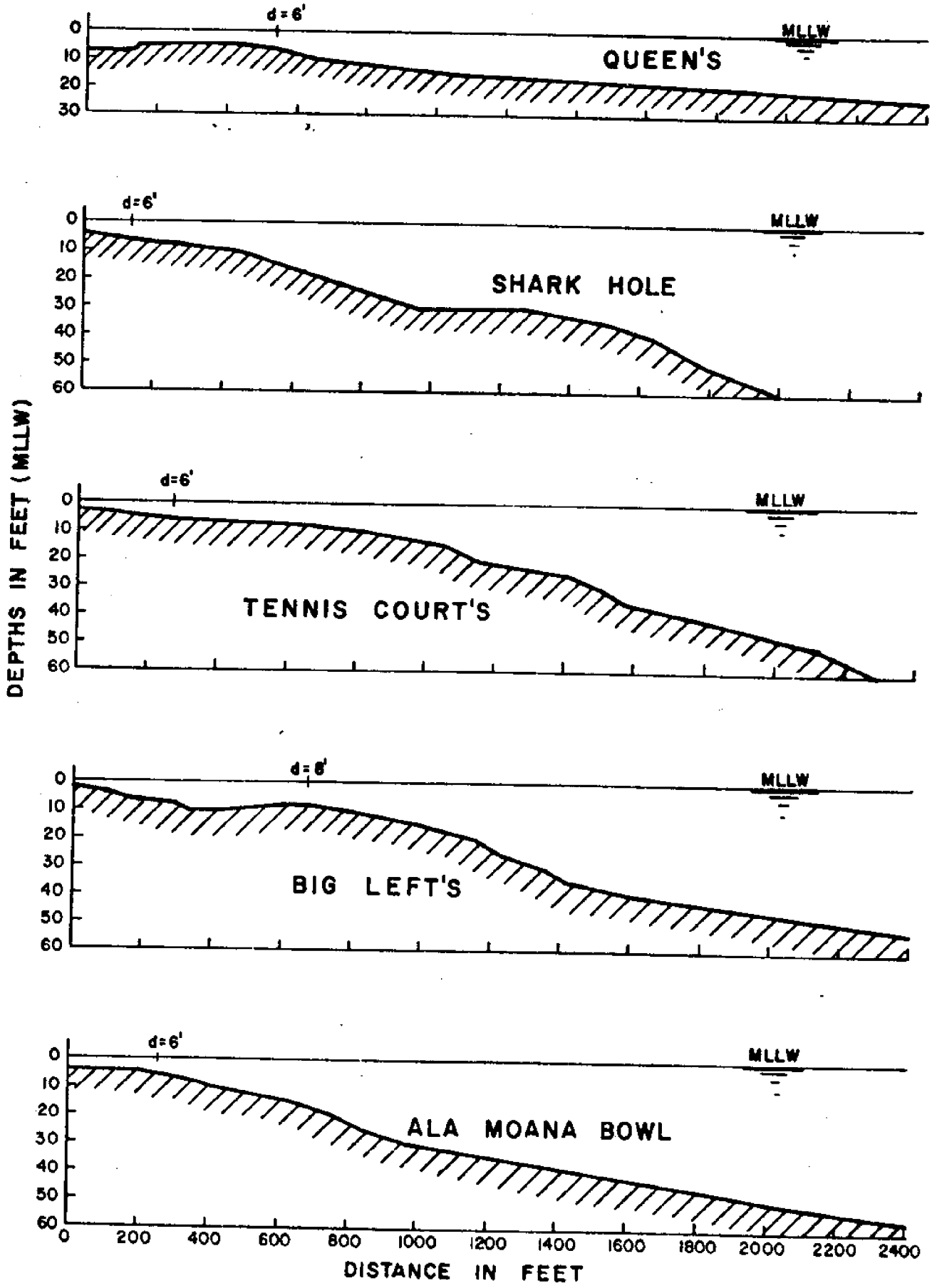


Figure 6: CROSS SECTIONS THROUGH SELECTED SURF SITES

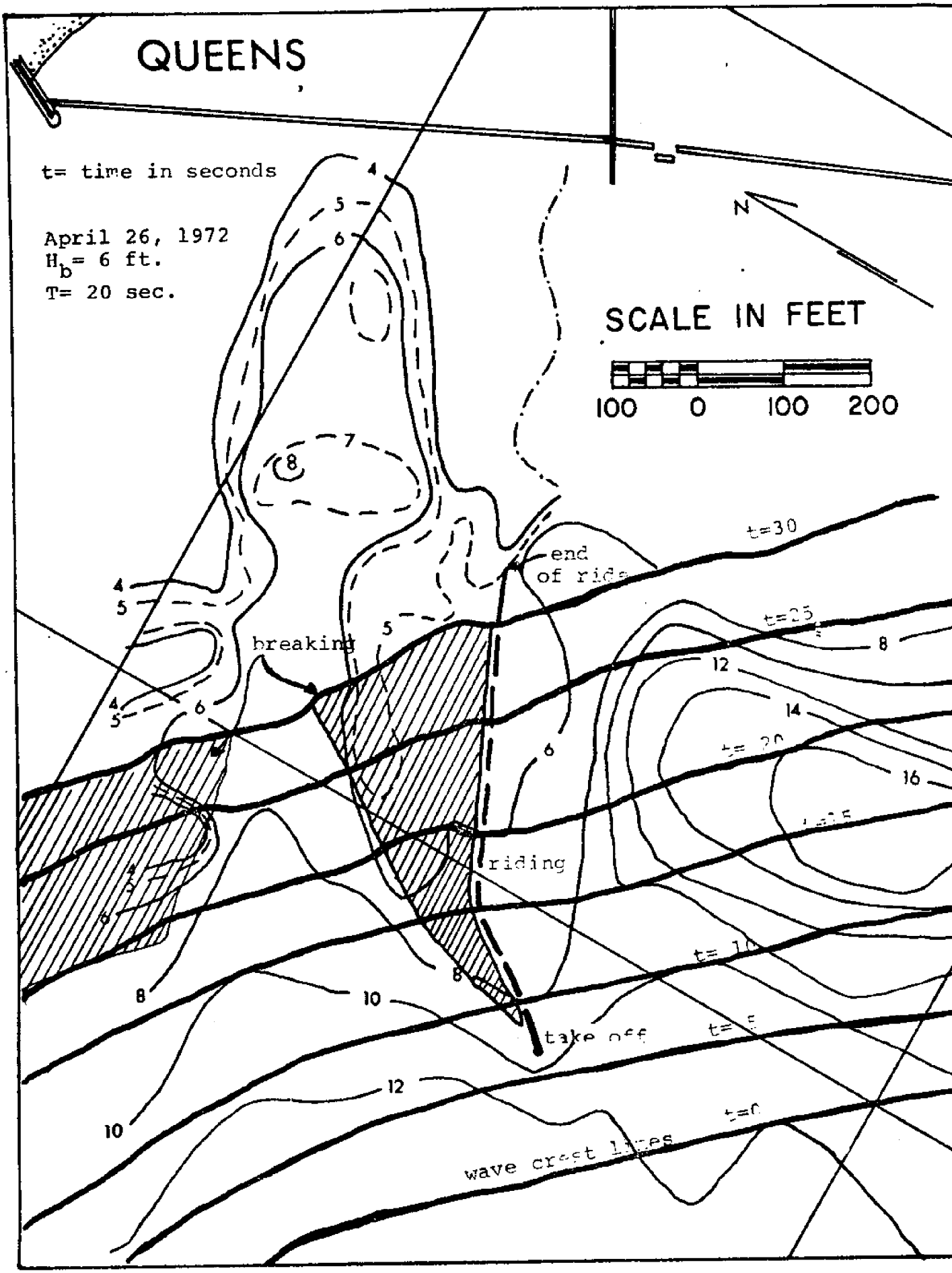


FIG. 7: Sequence of a Wave over Queens

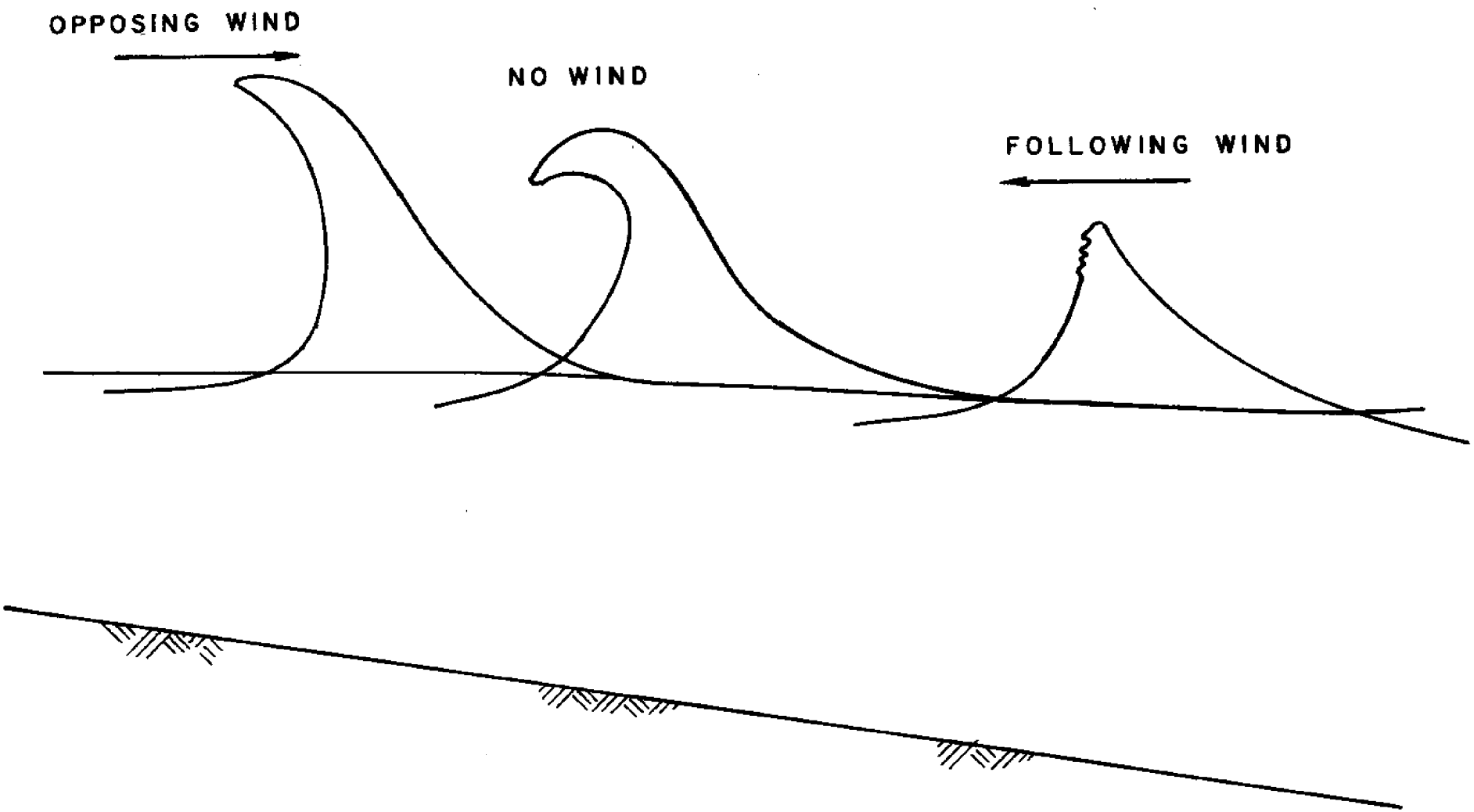


FIGURE 8: INFLUENCE OF WIND ON WAVE FORM

greater height breaking in shallower water. This improves the quality of wave form for surfing. An opposing wind with a velocity greater than 20 knots tends to spoil surfing conditions by producing a wind chop and air resistance which makes it difficult for the surfer to catch the wave. A component of wind following the wave tends to induce premature breaking, which spoils surfing conditions. The premature breaking tends to produce a lower relative height-to-depth ratio and more of spilling breaker-type. The onshore wind also generates a wind chop which impairs the water surface conditions. Figure 9 illustrates the favorable and unfavorable wind criteria. The percent probability of a surf site having favorable wind conditions can be determined by application of the criteria illustrated in Figure 9 with a wind rose spanning the appropriate wave season and daylight hours.

Tide

The tide can play a significant role in the properties of surf sites. Referring to the composite slopes presented in Figures 5 and 6, a small difference in water depth can make a significant difference in breaker height and form. An example is Big Lefts, which has a 6-foot minimum depth. A 2-foot rise in tide level could preclude a 6-foot wave from breaking. At Pipeline, a small change in tide for 15-foot breakers can change the slope over which the wave breaks, altering the breaker form. The tide effects are different for each site for each wave condition.

Components of a Surf Site

Components of a surf site are schematically shown in Figure 10. The site has a take-off area, riding area, return route, end-of-ride area, and board recovery area. Four general types of surf sites are shown in Figure 11. They include a straight parallel contour beach, a promontory, shoal, and channel. The latter three sites are the most common types. Figure 12 is a general surf site concept which can be modified into the above-mentioned sites. The shoal is modeled after Queens and could be considered a general type shoal after which an artificially-made shoal could be modeled. A large seaward slope provides an area over which waves transform into breaking. The seaward slope controls the breaker height and type. Flatter slopes diffuse the surfers over a larger take-off area, expanding the site capacity. Side channels on either side of the shoal create bottom contours which induce a peel angle. The channel also provides the return

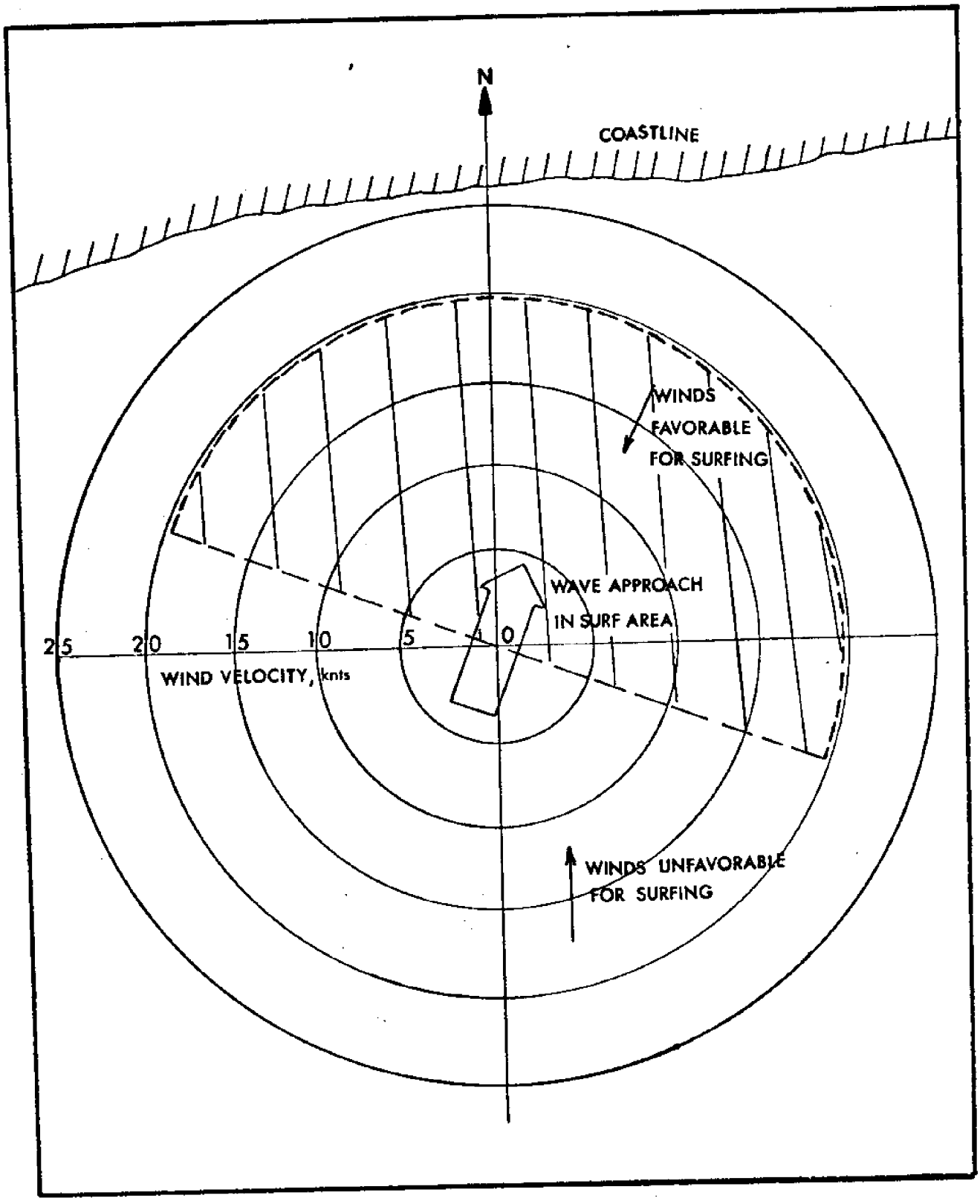


FIGURE 9 : WIND CRITERIA FOR FAVORABLE CONDITIONS AT A SURF SITE

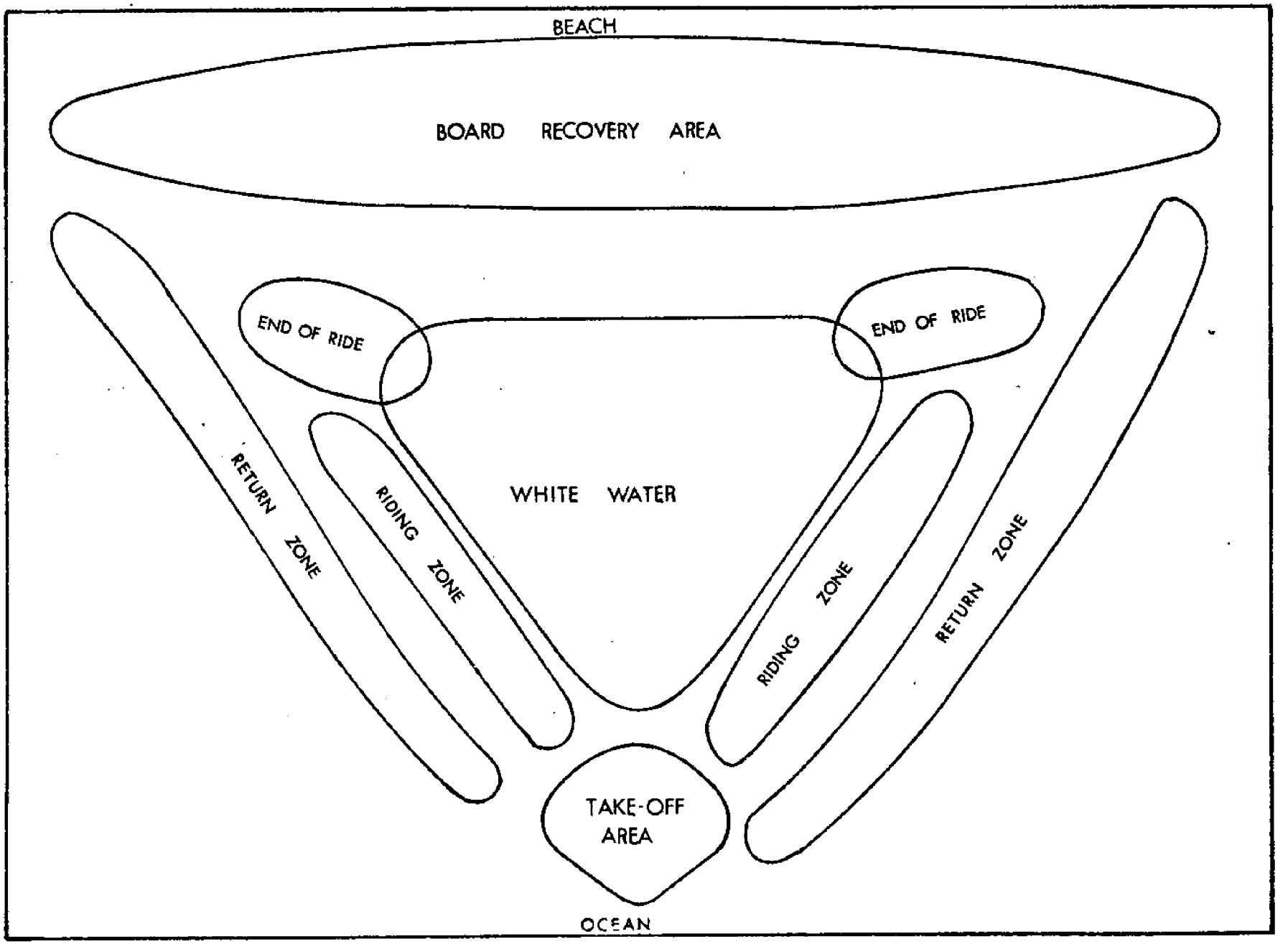


FIG. 10: Schematic of Surfing Area

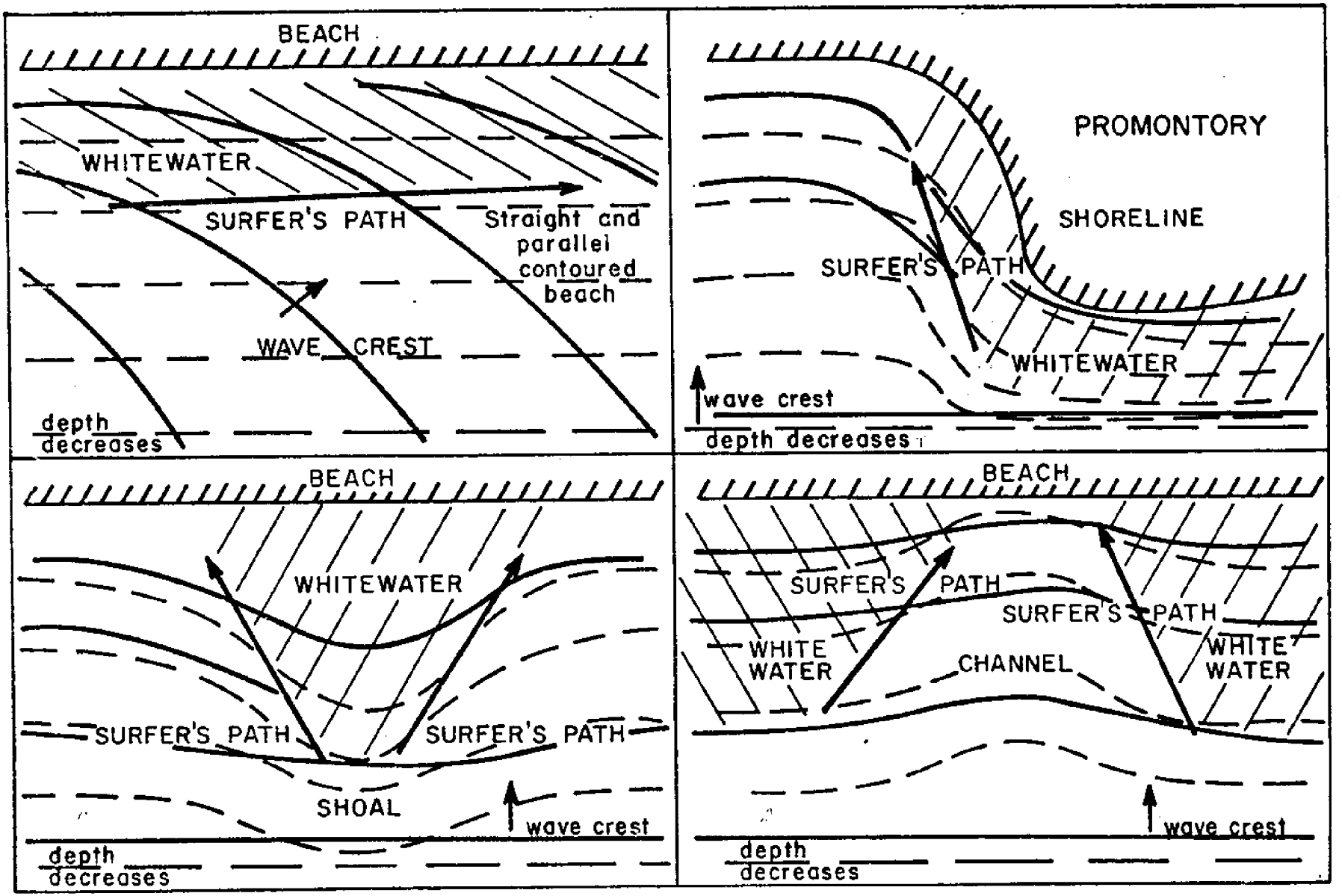


FIG. 12: Basic Surf Site Bathymetric Configurations

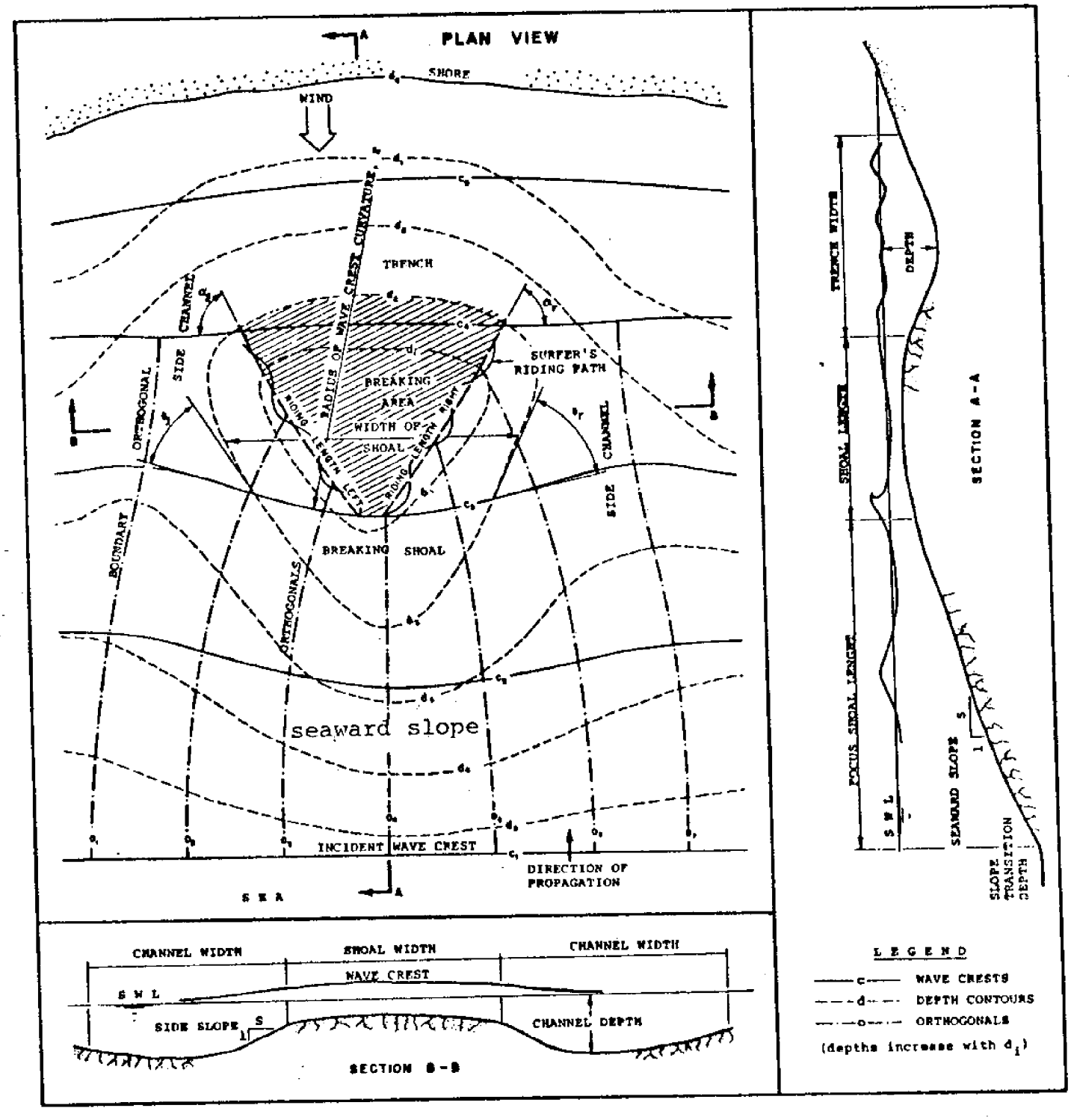
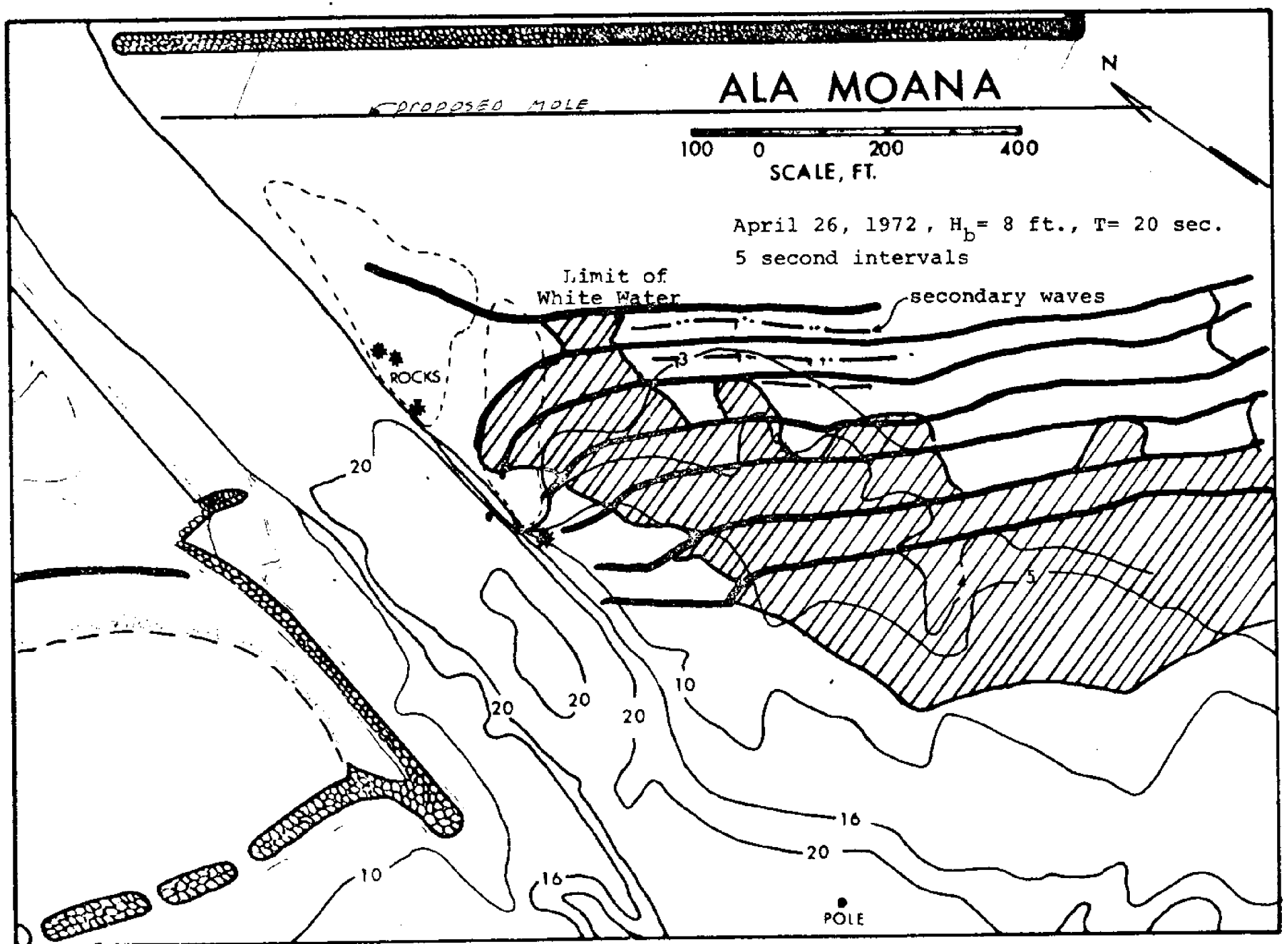


FIGURE 12: GENERAL SURF SITE CONCEPT

route. The trench on the landward side creates a board recovery area, which isolates the site from the beach and swimming area. Access to the site from land is mandatory.

Surf Site Preservation

Preservation of surf sites is the most important application of this study. An example of a study conducted by Walker (1974) is illustrated below to summarize concepts and illustrate application of the project findings to the purpose of preserving surf sites. The study site is Ala Moana. Figure 13 shows wave breaking patterns over Ala Moana. A 100-foot wide mole was proposed to parallel the seaward side of the existing breakwater. The purpose of a special study was to locate the surf site boundaries and determine direct and indirect impact of the proposed construction on the surf site. Field studies were conducted to outline the boundaries of the site. Special attention was placed on locating the end-of-ride and board recovery areas. Figure 14 shows the observed boundaries as a function of wave height. The probability of wave height exceedance, and therefore the probability of the surf site boundaries being exceeded by the given limits, was determined from analysis of wave height distribution and wind conditions. The wave height distribution is shown in Figure 15. This distribution was determined from a theoretical transformation of the Marine Advisors (1962) wave climate into a breaking wave climate. Figure 16 is a wind rose from which conditions of favorable winds at the site were determined. The Hickam station was used for Ala Moana. Criteria from Figure 9 were applied to the wind rose to determine the rose shown in Figure 17. The wind was assumed independent of the wave conditions. Table 2 summarizes the percent probability of wave height exceedance with favorable winds for Ala Moana. These probabilities are plotted in Figure 14 on the surf site boundaries. Construction of a mole 200 feet seaward of the existing breakwater would not directly alter the riding or board recovery areas for 99.7 percent of the year. Extension of the mole, however, could change the properties of reflected waves which could influence the surf conditions. A detailed analysis of wave propogation, decay, and reflection was made to determine the possible indirect effects. Figure 18 shows the changes in reflected wave orthogonals induced by construction of the mole. A 100-foot wide trench was proposed to provide a buffer zone for the board recovery area, to provide construction materials, and to reduce reflections. Table 3 summarizes the results of the reflection analysis. The effects of the proposed structures appear to have an insignificant indirect hydrodynamic influence on the characteristics of the surf site.


ALA MOANA
N
proposed mole
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SCALE, FT.
April 26, 1972 , H_b= 8 ft., T= 20 sec.
5 second intervals
Limit of White Water
secondary waves
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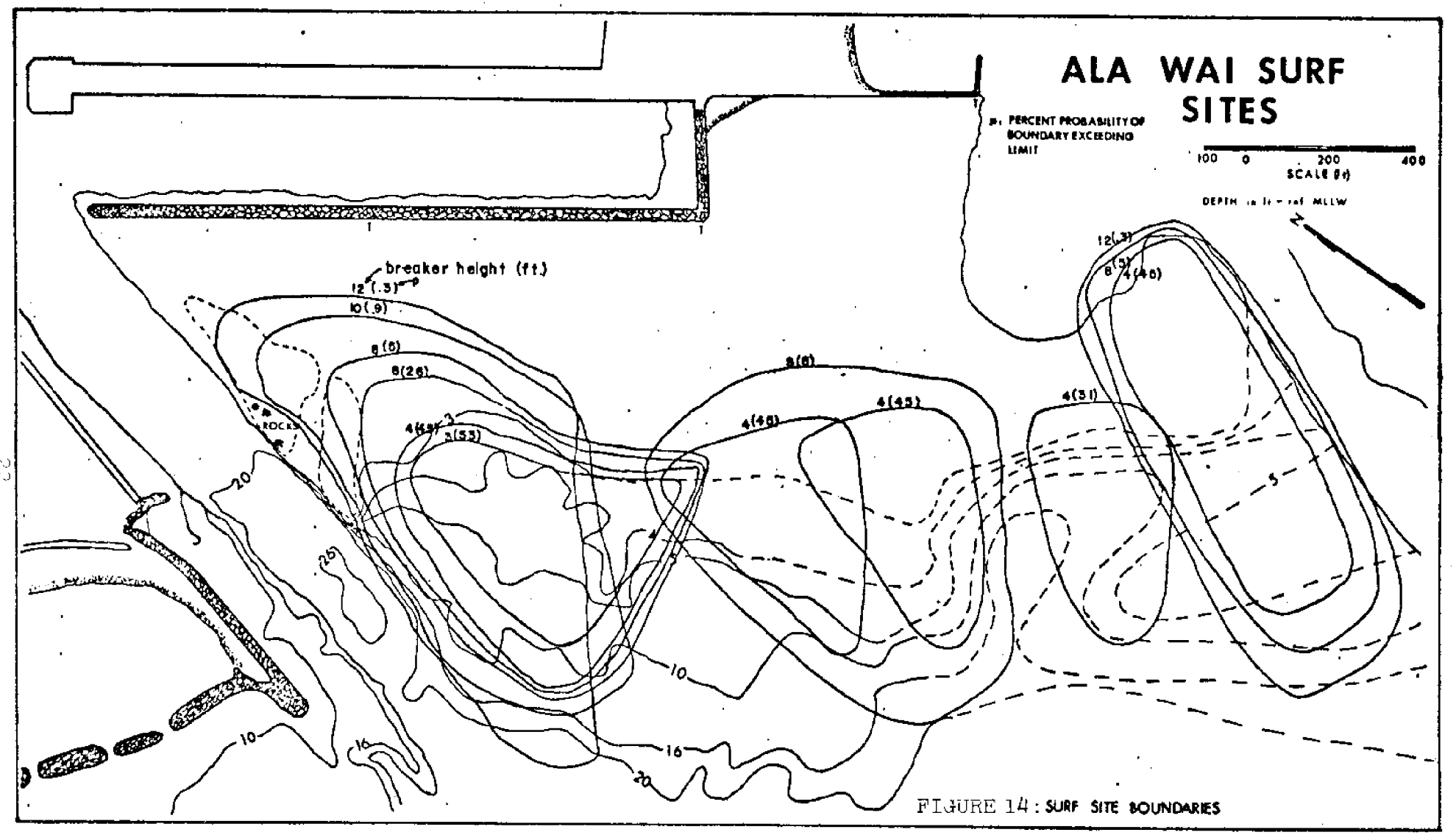
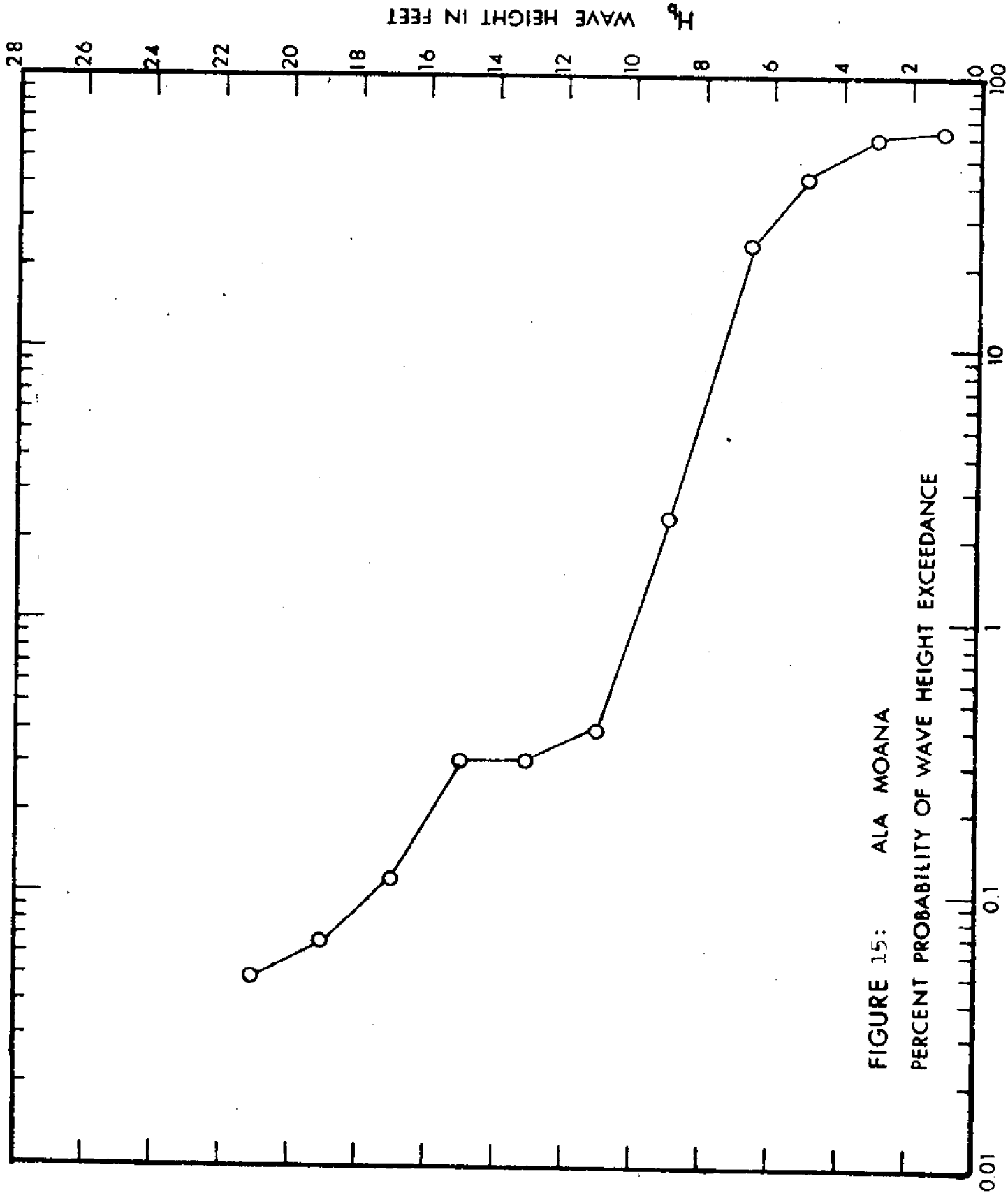


FIGURE 14 : SURF SITE BOUNDARIES


H_s WAVE HEIGHT IN FEET
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26
24
22
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12
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PERCENT PROBABILITY OF WAVE HEIGHT EXCEEDANCE
ALA MOANA

FIGURE 15:

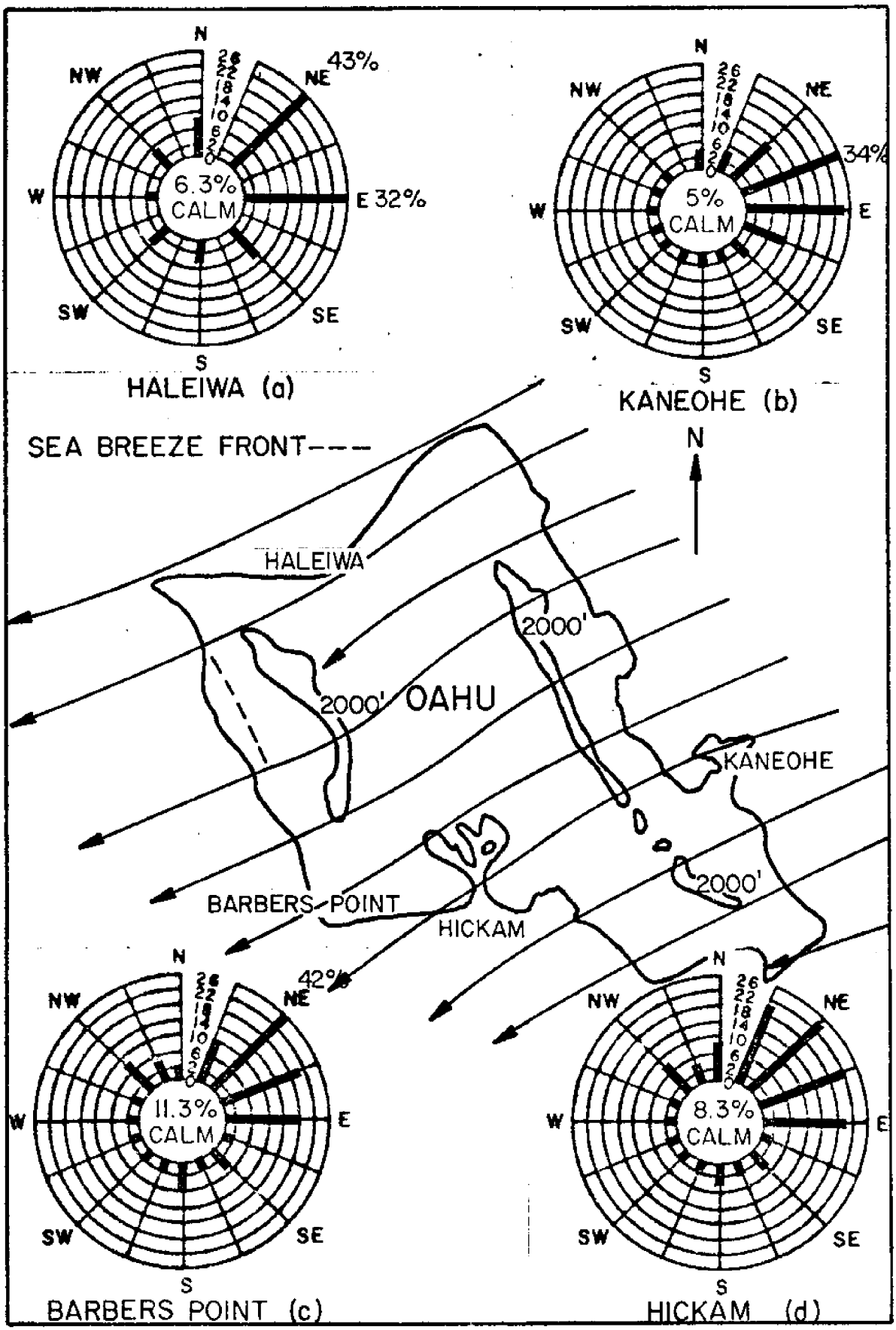

FIG. 16: Typical Trade Wind Pattern on Oahu

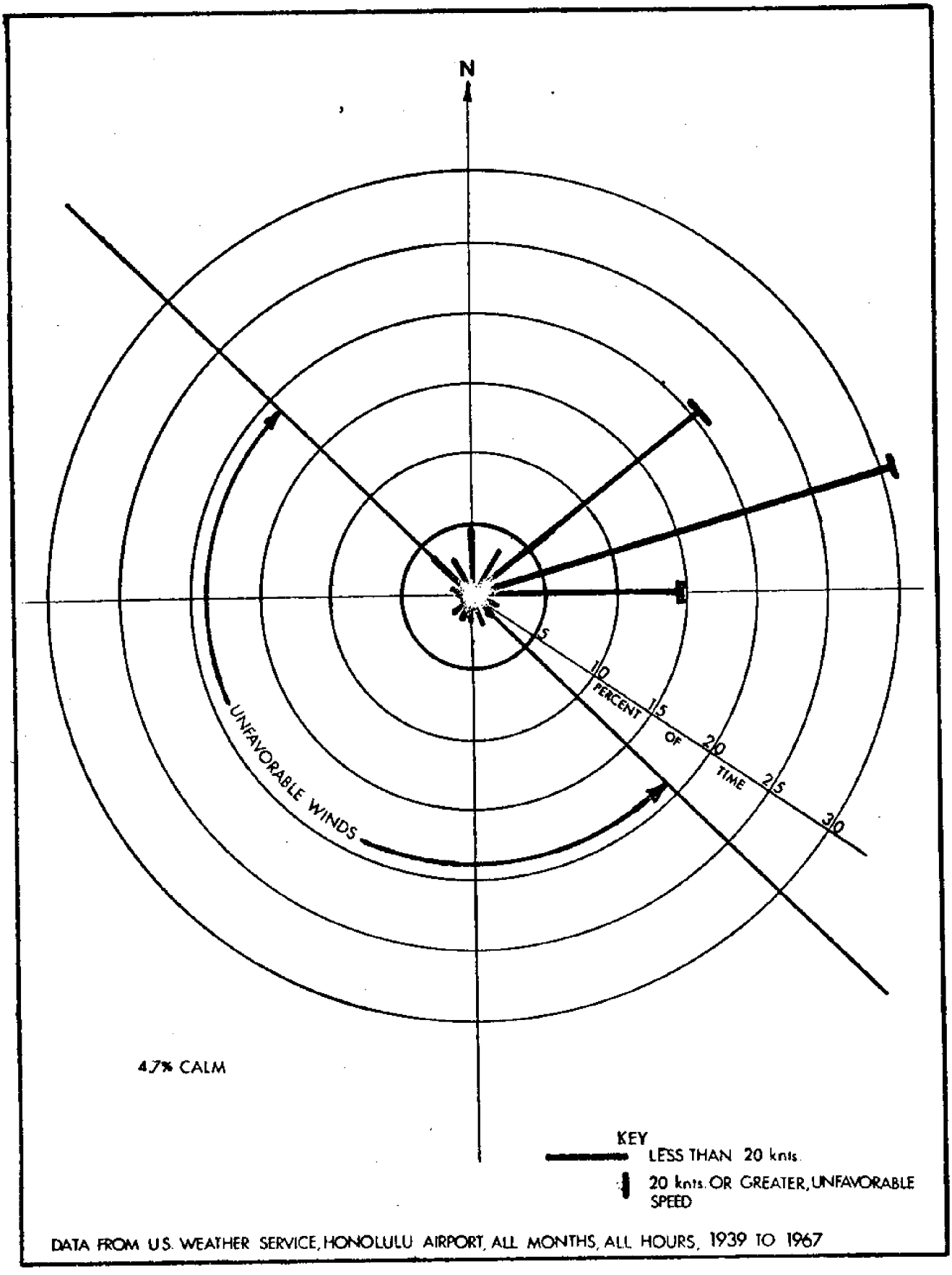

FIGURE 17: WIND ROSE FOR ALA MOANA

Table 2

PROBABILITY OF FAVORABLE SURFING CONDITIONS
AT ALA MOANA

H_b (ft.)	Per Cent Probability of Wave Height Exceedance CP (H_b)	Per Cent Probability of Wave Height Exceedance with Favorable Wind CP (H_b, W)
3	62.	53.
4	52.	45.
6	30.	26.
8	6.3	5.4
10	1.0	0.86
12	0.36	0.31
15	0.27	0.22

where CP is the cumulative probability of wave height exceedance and W is favorable wind conditions.

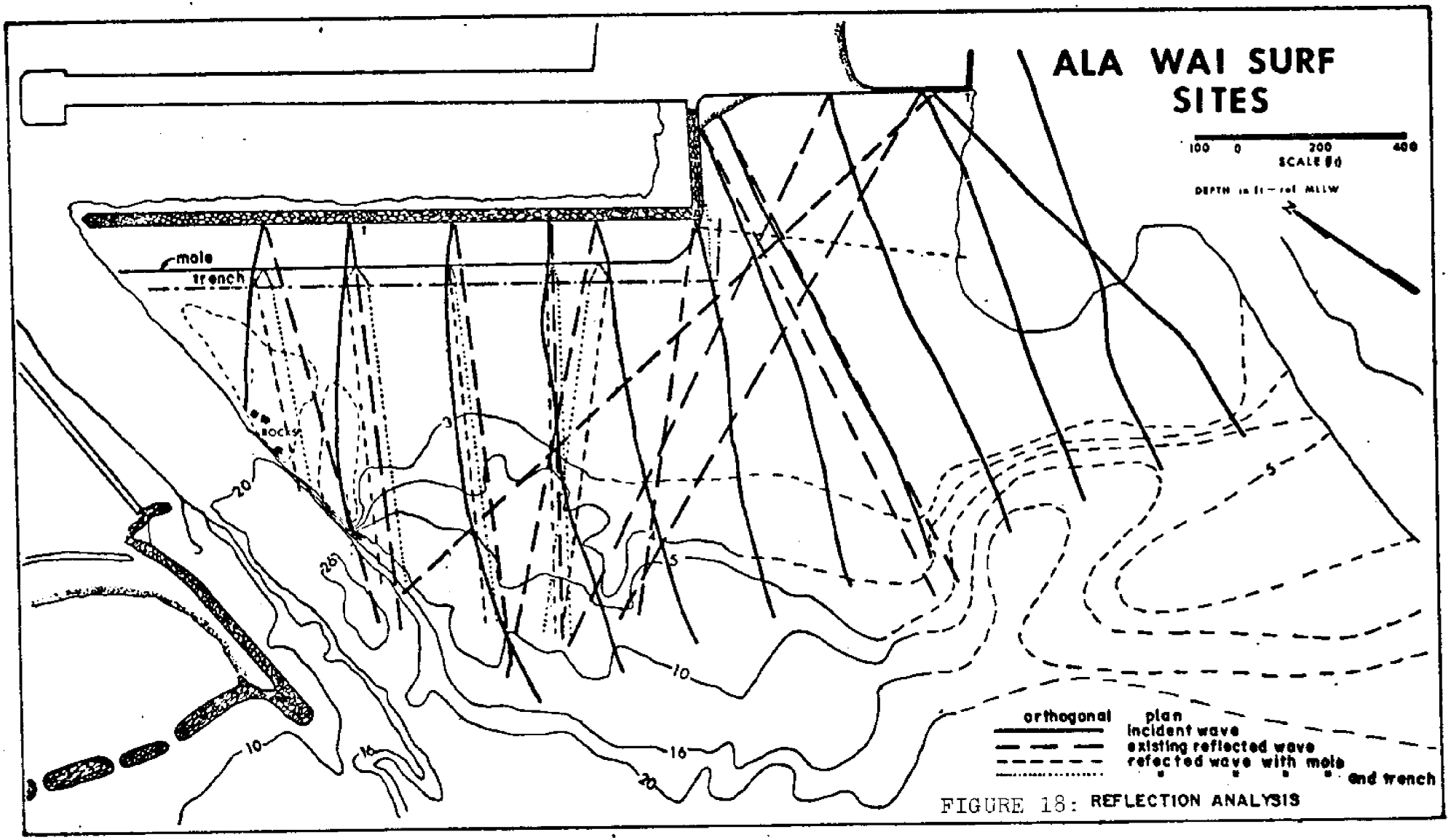

FIGURE 18: REFLECTION ANALYSIS

TABLE 3: Reflected Waves at Ala Moana

H_b ft	T sec	τ ft	d_b ft	H_o ft	Existing H_1 ft	Break-water H_2 ft	Breakwater with trench H_3 ft	Influence of breakwater $\frac{H_2-H_1}{H_1}100$	Influence of breakwater and trench $\frac{H_3-H_1}{H_1}100$	Influence of trench $\frac{H_3-H_2}{H_2}100$	Proposed $(\frac{H_3}{H_b})100$
4	8	0	4.68	2.41	0.175	0.210	0.196	20.0	12.0	-6.6	5.2
8	8	0	9.36	6.21	0.224	0.264	0.250	17.8	11.6	-5.3	3.3
12	8	0	14.04	10.48	0.275	0.320	0.306	16.3	11.2	-4.3	2.6
4	12	0	4.68	1.81	0.209	0.254	0.241	21.5	15.3	-5.1	6.3
8	12	0	9.36	4.66	0.234	0.277	0.263	18.3	12.3	-5.0	3.4
12	12	0	14.04	7.87	0.275	0.319	0.305	16.0	10.9	-4.3	2.6
4	16	0	4.68	1.12	0.204	0.244	0.230	19.6	12.7	-5.7	6.1
8	16	0	9.36	2.88	0.307	0.367	0.355	19.5	15.6	-3.2	4.5
12	16	0	14.04	4.87	0.290	0.338	0.325	16.5	12.0	-3.8	2.8
4	8	2	4.68	2.41	0.485	0.538	0.525	10.9	8.2	-2.4	13.4
8	8	2	9.36	6.21	0.539	0.595	0.581	10.3	7.7	-2.3	7.4
12	8	2	14.04	10.48	0.602	0.659	0.647	9.4	7.4	-1.8	5.4
4	12	2	4.68	1.81	0.557	0.629	0.617	12.9	10.7	-1.9	15.7
8	12	2	9.36	4.66	0.578	0.639	0.627	10.5	8.4	-1.8	7.9
12	12	2	14.04	7.87	0.602	0.659	0.647	9.4	7.4	-1.8	5.4
4	16	2	4.68	1.12	0.498	0.555	0.543	11.4	9.0	-2.1	13.8
8	16	2	9.36	2.88	0.689	0.771	0.762	11.9	10.5	-1.1	9.6
12	16	2	14.04	4.87	0.628	0.690	0.677	9.8	7.8	-1.8	5.7

where H_1 = existing reflected wave height in surf zone;

H_2 = reflected wave height in surf zone with mole; and

H_3 = reflected wave height in surf zone with mole and trench.

Surf Site Design

The creation of an artificial surf site is the most interesting application of the study. The objective of the design is to transform incident wave properties into breaking waves with desirable wave breaker-type and peel angle. The breaker height is primarily controlled by the incident waves. The shoal would have little influence on refraction effects which would amplify the wave height. Walker (1974) has shown that refraction over a surf shoal is of minor importance. In fact, refraction analyses must include the effects of breaking and finite height on wave celerity which tend to reduce refraction effects over a surf shoal. The primary function of the shoal is to produce a depth differential to produce a peel angle. Design of a surf site is within the state of the art. The shoal or channel required to produce favorable breaker from and peel angles must be designed for the predominant wave direction. The design of a surf site must be done for each site location. A general design is not applicable to all locations.

Future Studies

Adequate information is available concerning the basic concepts of a surf site to make an evaluation of the influence of a proposed structure on that surf site. Field studies may be required to calibrate methods and define boundaries. Analyses similar to the Ala Moana case should be performed in order to evaluate the direct or indirect effects of a project on a surf site. Two areas of research that are most essential to design of a surf site are the stability of the shoal and effects of the shoal on the adjacent beaches. The primary construction material is stone riprap. Little design criteria exist for stability of a submerged shoal subjected to breaking waves. The shoals will cause a reduction in wave energy arriving in the immediate area shoreward of the shoal. Wave diffraction patterns will tend to form a spit behind this shoal. Consequently, the shoal will influence the shoreline. Field and model studies are required to further understand how the shoreline will be influenced. Another important area of research is the transformation of waves over shoals in three dimensions. Relationships between breaker height and peel angle over shoals of various dimensions are required to better understand the required dimensions to transform a wave into a surfing wave. Figure 19 illustrates the response of a wave to a shoal of varying shoal widths.

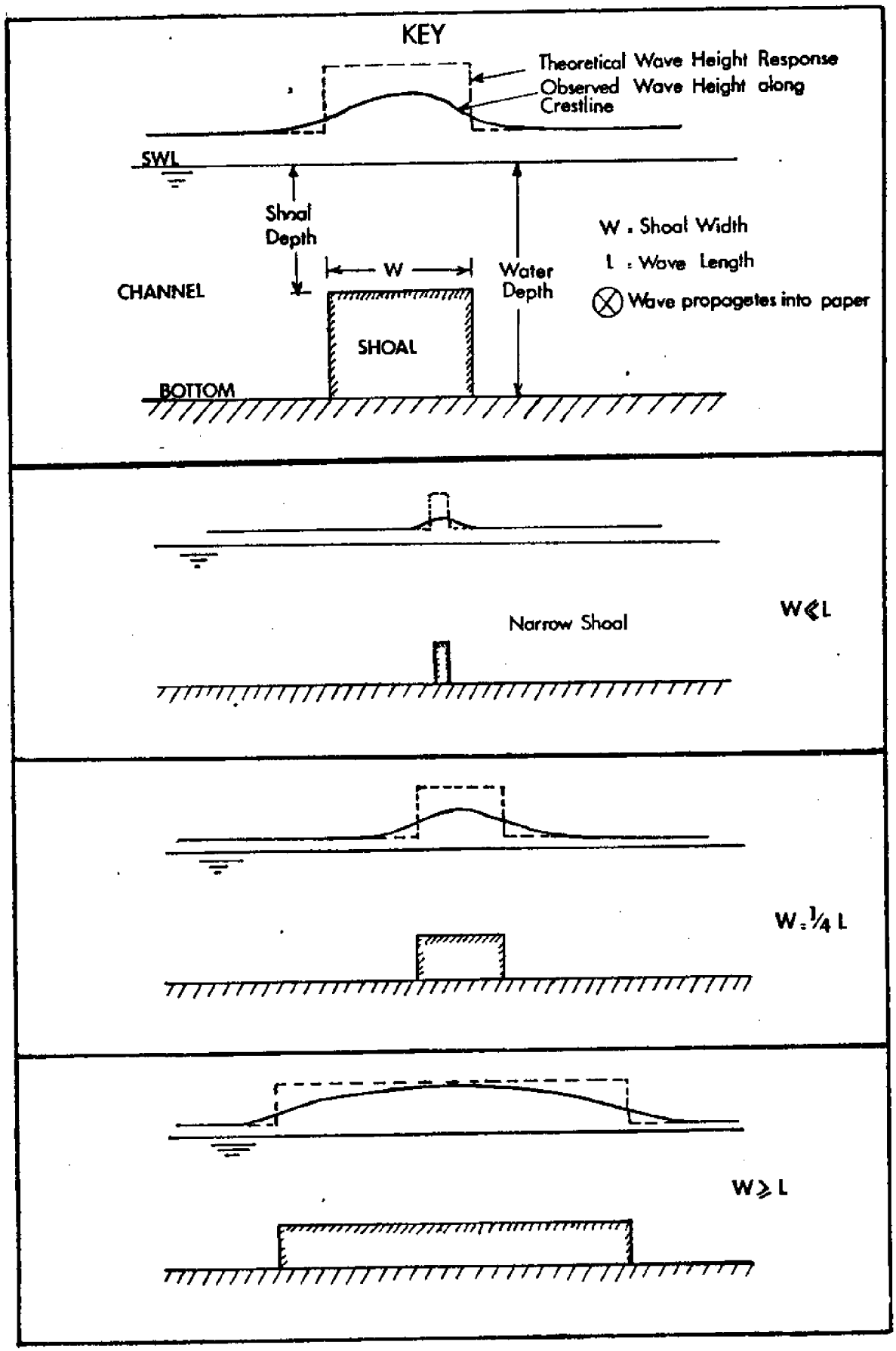

FIGURE 19: DIFFRACTION EFFECT OF SHOALING OVER A 3-DIMENSIONAL OBJECT

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BEACH AND SURF PARAMETERS WORKSHOP

November 7, 1975

SUMMARY OF BEACH PARAMETERS STUDY

By Dr. Jurjen A. Battjes

1. Introduction

A three-year study has been made of several Hawaiian beaches, with the following objectives:

a. Identify relationships between various dominant parameters in the coastal zone and their effect on beach stability.

b. Determine general characteristics and modes of sand transport of selected beach areas.

c. Evaluate beach cusp behavior of selected beaches.

d. Study the influence of headlands and natural formations on beach stability.

Field surveys were carried out at the sites selected for the study, but the extent of the measurements differed for each of the sites. The data collected included aerial photographs, beach profiles in selected ranges, and sediment size distributions; in a number of locations, wind, waves, tides, and currents were measured as well.

The data gathered in the field studies, interpretations thereof, and recommendations based thereon, have been given in a final report on the study. No attempt will be made during the workshop presentation to cover the complete study. Instead, the results for a few selected cases and typical aspects will be presented; these are briefly described below. They cover the study of Waikiki Beach, the study of dynamic beach behavior as related to sand waves, and the study of the effects of natural formations such as headlands, reef, etc., on beach stability.

2. Waikiki Beach

The field studies at Waikiki Beach represented a large portion of the total study effort. All of the parameters mentioned above were included in the investigations. The main emphasis was on the current measurements, which were carried out by means of dye injections and drogues. In addition, fluorescent tracer tests were carried out to determine the sediment patterns in selected areas.

During ebb as well as during flood, the tidal currents off Waikiki Beach were directed eastward, with maximum values of about 1 ft/sec. This would also indicate the predominant direction of sediment transport outside the area of breaking waves.

The nearshore currents are mainly wave-induced. The results of current measurements and fluorescent sand tracer experiments confirmed the predominance of a northwest sand drift along the beach. A significant cause of loss of beach sand was found to be the existence of rip currents, the major one being located off the Royal Hawaiian Hotel, with maximum measured velocities of 3 ft/sec. However, tracer experiments showed that the net sediment transport in the offshore Halekulani channel was shoreward, rather than seaward, contrary to previously held opinions.

An investigation of the sediment properties in the Waikiki Beach area revealed that the characteristics of the offshore sand deposits in various locations are similar to those of the beach material, so that the offshore deposits may be useful as material for artificial beach nourishment.

With respect to possible measures for beach restoration and stabilization, it is believed that the mere construction of groins is not the most suitable way to cope with the erosion at Waikiki. Replenishment of the beach by

artificial nourishment (e.g. by a special sand pump arrangement) will continue to be the prime solution to the problem. However, a compartmentalization of the beach through construction of groins will be helpful to reduce sand losses from the longshore drift. Special precautions are necessary to avoid generation of rip currents along the groins, with the attendant loss of sand to deeper water. This can generally be accomplished by construction of Γ- or T-groins.

3. Dynamic Beach Behavior as Related to Sand Waves

Beach cusps could regularly be observed on several of the beaches which were studied, among others Mauna Kea Beach and Hapuna Beach on Hawaii, Hanalei Bay Beach on Kauai, Holupoe Beach on Kauai, Puu Olai Beach and Wailea Beach on Maui, and Waimanalo Beach on Oahu. The occurrence of cusps and other types of longshore sand waves corresponds to a pulsation of the rate of sand drift along the shore. The nature of these features, and their function in beach dynamics, were made a particular object of study. Some of the findings can be summarized as follows:

a. Some beaches were observed to have both relatively short cusps (90 ft in length on the average), and giant cusps with wave lengths many times the length of the shorter cusps.

b. Detailed measurements of the small cusps at Waimanalo Beach showed that these were stable and did not migrate alongshore.

c. Some correlation between cusp length and beach slope was observed, but no definite conclusion could be drawn as to the mechanism controlling the height and length of the cusp.

d. Analysis of the behavior of Waimanalo Beach over a larger section revealed the existence of a standing wave with a length of approximately 8,000 ft.

4. Effect of Natural Reefs and Rock Formations on Beach Stability

One aspect of beach behavior which received attention in the study was the effect of natural reef and offshore rock formations on beach stability.

Beaches studied in this context included Port Allen Beach and Poipu Beach on Kauai, and Baldwin Park Beach and Spreckelsville Beach on Maui. A preliminary investigation was made of the characteristics of these beaches.

The beaches studied displayed a number of characteristic patterns such as crenulate bay shapes, spits, and complete and incomplete tombolo's, depending on such factors as the spacing between headlands (if any), the fact whether or not the headland acts as a virtually complete barrier to the longshore sediment transport, the orientation of the beach with respect to the direction ofthe incident waves, the variability of this direction, etc. The beach slope is governed mainly by the size of the beach material and the degree of exposure of the beach, coarser material and greater exposure giving rise to steeper slopes of the beach face.

As mentioned above, this part of the overall study was of a preliminary nature, since it was not possible within the framework of time and money available to make detailed studies of the selected sites. It was rather the objective to identify beach situations that could become objects of future study. The results indicate good possibilities of learning invaluable lessons from further quantitative studies of nature's way of beach stabilization. Knowledge so obtained can hopefully be put to use in conceiving such measures to combat undesirable beach erosion as will be not only effective but also in harmony with the natural environment.

ALIENATION AND THE ENVIRONMENT

A SOCIAL PARAMETER*

by John Kelly

Abstract

New material is added in this paper to a discussion in the 1973 Surf Parameters report on alienation of users from the environment, of authority from users, and of expertise from authority. Questions of alienation are presented as relevant social parameters in considering the uses and abuses of Hawaii's shoreline.

Alienation, while appearing to arise from individual limitations, is traced to contemporary systemmic or structural forces that replace local environmental with market dependency, that separate authority from users of the environment, and tend to corrupt or segregate expertise from authority.

The contemporary example presented is a detailed account of the degradation of a portion of Keehi Lagoon fishery over a quarter century from illegal dumping with discussion of bureaucratic fumbling and ignorance of actual conditions, overt deception by government officials, and failure to enforce existing laws. Hawaii's watergators are shown to thrive in the occluded depths of public deception.

This reasoning is illustrated with a comparison of the shoreline environmental abuse stemming from today's profit-oriented market economy, and the malama (conservation) system and sanctions of pre-contact Hawaiian society.

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*A paper presented at the Beach and Surf Parameters Workshop, Department of Ocean Engineering, University of Hawaii, Nov. 7, 1975

Nearly all of the environmental ills that beset Hawaii today are the result of piecemeal planning, headlong growth, and a view of progress overwhelmingly keyed to the motive of private profit.

Stewart L. Udall
Hawaii State Open Space Plan

ALIENATION AND THE ENVIRONMENT
A SOCIAL PARAMETER*

by John Kelly

In the final report on the Surf Parameters project (Kelly 1973), I raised the point of alienation as a fundamental aspect of Hawaii's shoreline environmental degradation today: of alienation of users from the environment, of authority from users, and of expertise from authority.

Here I would like to extend somewhat that discussion and give a few comparative examples with pre-contact Hawaii.

Alienation defined Alienation is defined as a condition of being contradictory, distant, foreign, hostile, impertinent, inappropriate, irrelevant, opposed, remote, strange, unconnected, unlike. Its verb means estrangement, an act of separation or of selling. It also carries the meaning of deprivation of mental power, derangement. A synonym is insanity. Alienism is the study and treatment of mental derangement.

Some studies of alienation The many forms of alienation are among the much studied and urgent questions of our present national condition. Some of its origins in technology and managerial structures have been examined by Packard (1959, 1960), its urban forms and their consequences by Brugman et al (1971), its appearance in

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*A paper presented at the Beach and Surf Parameters Workshop, Department of Ocean Engineering, University of Hawaii, November 7, 1975.

politics and its social manifestations by Pappenheim (1959). The institutional roots and psychological consequences of alienation have been examined by Reisman et al (1953) and its appearance in the form of political power elites by Mills (1956). Marx exposed its genesis in division of labor, the market economy and the wages system (1967), Lundberg its consequences in the widening maldistribution of wealth (1968). Dubois (1968) shows one of its social forms as racism. Locally, alienation of land from the people has been analysed by Kelly (1957) and Levy (1975) among others. These are but a few of the significant studies of alienation. Profound symptoms of social alienation underlie the morbid epidemic of drug use as well as what experts now describe as the nation's uncontrollable crime. The Pentagon Papers, Watergate, and post-Watergate revelations including last month's congressional hearings on national security agencies have shown the extent to which powers of government are alienated from the people.

Study after study of environmental problems document or throw light upon the state of alienation of much of our social system from natural processes and from truth.

In this paper, we will look at some results of alienation as they appear in a portion of Hawaii's shoreline environment within which the surf parameters study was conducted. The shoreline area chosen is the approximately 9-mile segment from Pearl Harbor to Waikiki, and in particular the Keehi Lagoon sector. Comprising only about one percent of the state's 1000-mile shoreline, the Pearl Harbor to Waikiki segment is the most critical area due to the proximity in nearby metropolitan Honolulu of most of the state's urbanized population. For these city-bound masses, among the most urgent needs

today is that of re-establishing contact with nature and her natural processes, to counter the insidious effects of the many forms of urban alienation arising from the market economy. For example, many urbanites in Honolulu, surrounded by the Pacific Ocean, cannot swim, have never walked a reef, and know little or nothing about the marine eco-systems.

One of the reasons for this alienation is the fact that not one foot of this 9-mile shoreline segment, adjacent to the state's most populeus city, remains in its natural state, or in the enhanced condition left by Hawaiian civilization.

This south shore Oahu shoreline was once a site of intensive Hawaiian aquaculture and a productive marine food resource. Its two main estuaries--Pearl Harbor and Honolulu Harbor (as named today)--and adjacent lagoons were famous as fishing areas with a diversity of estuarian eco-systems. My 1973 surf parameters report lists some of the studies that have documented the grave extent of pollution of the lagoon and both harbors today. The physical deformation is another subject, largely untold in the literature. The clean waters of this segment prior to commercial and military ship traffic in the harbors and prior to heavy dredging begun around the 1930's are legendary. They are remembered by many old timers today.

An early map of the area was made in 1817 by the cartographer aboard the Kotzebue expedition. It shows numerous Hawaiian villages settled along this shoreline. Interspersed among the habitation sites were a large number of developed "fishbeds" (fishponds). By 1902, when decline of many fishponds had set in, Cobb observed and listed 41 fishponds in the Pearl Harbor-Keehi area and 15 in Kewalo-Waikiki--

a total of 56, the largest of which was 332 acres. These comprised 73 percent of those he listed for Oahu. In this first federal study of Hawaii's fisheries, Cobb observed that Hawaii's fishponds were the only place in the United States where fishponds "...are found on such an immense scale and put to such general and beneficent use" (ibid:427). The figure is actually low, Cobb says, since probably "...not more than one-half the number of ponds [are] in use today [1902] that there were thirty years ago" (ibid:428). Not one of the 56 fishponds remains in the entire 9-mile segment today, even as a curiosity for tourists! The decline in fishpond operations has been attributed to their confiscation for urban developments with higher profit rates, destruction of the Hawaiian communal upland-lowland labor system, Hawaiian depopulation, loss of skills, invasion of water hyacinth and mangrove, siltation from land mismanagement and other factors (Kelly 1975; Cobb 1902; Summers 1964).

The total catch of Oahu's fishponds, of which 73 percent were within the Pearl Harbor-Waikiki segment, for 1902 was 560,283 pounds, 71 percent of them being mullet, valued then at $139,714 (Cobb 1902:431). Using Cobb's figures and estimate of a decline in use of half the fishponds in this area since 1872, the per capita consumption that year (1872) of fresh local fish for the City of Honolulu would have amounted to approximately 55 pounds per person per year. The Honolulu population for 1831 was slightly less than for 1872. Moreover the fishpond technology was probably fully operative in the earlier times. Hence, the per capita consumption was probably considerably higher in earlier times.

Even with this conservative method, the per capita consumption then was nearly three times its highest figure in the two decades from 1948 which was 20.6 in 1951. The 10-year average to 1968 was 9.1 pounds per person per year. The estimated quantity of fresh fish marketed

shows a decline of over 26 percent comparing the average marketed weight of fresh fish between the two decades beginning in 1948; thus the decline in per capita consumption was not primarily due to a rising population. Assuming that eating freshly caught local fish is a good thing for any population, one could safely assume that rising production should accompany rising needs, but the opposite occurred. The above computations are from Cobb (1902) and Table 6-2 on Hawaiian fish landings reported in "Hawaii and the Sea" (DPED 1969).

Hawaiian fishponds should be looked at as part of the former overall life system, orientation and productive activities of the people, especially in the shoreline villages where the population was well distributed. The fishponds should not be looked upon, as some are wont to do, as unrelated economic units of activity out of the context of Hawaiian social and productive activity. It has been popular with the denigrators of Hawaiian lifestyle to attack the operation of fishponds as uneconomic and labor-intensive. Cobb (1902) described them as requiring very little labor, almost self-sustaining, but Kelly (1975) shows a fishpond requires many skills and is dependent on a properly maintained upland water control system as well as local environmental integrity.

The fishponds both depended upon and enhanced the populations of free ocean mullet and other species by providing predator-free sanctuaries in the small fry ponds, segregated within the larger fishponds, and were nourished by tide-borne schools of free swimming adults (Cobb 1902). They also depended upon clean nutrient-laden ocean waters provided by tide and wave induced water transport which encouraged the preservation of the integrity of reef flats seaward of the ponds. Also, the fishponds

were integrally related to the upland maintenance of fresh water rivers and streams essential to mullet husbandry (Kelly 1975). Most importantly, fishponds provided an ever-present supply of fresh fish protein for the surrounding populations obviating the need for refrigeration and other methods of food preservation. Thus, Hawaiian fishponds were an integral part of the well-being of the shoreline communities and environment and helped to hold together the social and productive lives of the people and maintain the natural eco-system at a high level of usefulness.

Some persons have attempted to justify the decline and destruction of fishponds and other works of Hawaiian civilization saying that they were only built for and used by an oppressive system dominated by feudal chiefs--that the commoners gained nothing from them. This unscientific 19th century view was given currency by missionary and market economy advocates evidently anxious to cover up their own sins of genocide against Hawaiian civilization. Kelly (1967) has examined the problems of seeing in a true light the Hawaiian subsistence economy and its communal social relations through the prismatic observations of missionaries and capitalist entrepreneurs.

The absurdity of these prejudices is seen in comparing the small number of chiefs and their retinues within the pyramidal-shaped caste system and their limited capacity to consume (Sahlins, personal communication 1975, and unpublished manuscript) with the output capacity of the fishponds, to say nothing of the farms and other forms of food production of which the fishpond system was an integral part, at the height of their development. Kelly (1969) has shown the old system of sharing and cooperative exchange among the maka'ainana (commoner) fishermen and farmers, the customs of which survive to this day. To consume the surplus set aside for them under the old

system, the chiefs and their retinues had to move from place to place, literally taking their stomachs to the food, rather than the other way around. It is an old Hawaiian saying that "the top stone rolls," the people of the land (maka'ainana) residing for the most part on their farms and in the villages (Sahlins, personal communication, 1973 and unpublished manuscript).

This brief resume of what is now known of the presence and importance of the shoreline fishing village traditions with the central importance of the fishponds is significant to our discussion of alienation arising from the present market economy. For, as we have shown, the Keehi Lagoon area was prolific as a fishery. Some land districts extending from the backshore to the outer reefs were known and identified as such including the Mokauea Fishery and numerous others. It is here that Hawaii's most desultory and harmful examples of plunder and destruction of the shoreline have occurred and continue to take place.

Summary of a case history In December 1973, perhaps the most notable case of pollution and illegal industrial dumping to occur in the local shoreline area came to public attention--the notorious Keehi Lagoon dumping case. The area is under the jurisdiction of the Harbors Division of the state transportation department. Aerial photogrammetry by R. M. Towill Co. from 1950 through 1973 shows 32.5 acres of public submerged lands filled in by industrial dumping. Visible and sub-surface evidence recovery by state investigators confirmed that industrial waste materials had been dumped including solid and liquid cement, cement products, bitumuls, road topping and associated petrochemicals, industrial rubber tires, old machinery, a barge, various metal products, cement truck parts, lime and other batching tailings from cement mixing, and many other industrial wastes.

The dumping had occurred over a long period of time, approximating a quarter century. The industrial dumping, the character and markings on the materials such as dating on cement slabs by the manufacturer, clearly identified the sources. These were HC&D, a cement fabricator, Pacific Concrete & Rock Co., a cement fabricator, and Hawaiian Bitumuls and Paving Co. All three are principle fabricators and suppliers of their products locally. The government is among the principle purchasers of their products. From the air, the coloration of the dumping area corresponded to the respective products: dark gray near the HC&D plant for finished cement products, light gray near PC&R for the liquid cement products, and black or dark colored next to Hawaiian Bitumuls & Paving Co. The three companies occupy the area side-by-side.

Melvin Lepine, DOT Harbors Division chief, estimated the land value at $10 to $20 a square foot (Interview 1974) which would total from $14 to $28 million for the value, at industrial land prices, of the submerged publicly owned (state) lands covertly and illegally converted to private use by the three companies.

Old maps and federal records reveal 18 fishponds in the area with, as mentioned above, a former high productivity of mullet. Several of the larger of these fishponds comprised the dumping area. Directly across from the dumping site at a distance of about 300 yards is the Keehi Lagoon Park, a large public facility with an extensive waterfront beach bathed by the same waters as at the dumping site.

In addition to the destroyed fishponds, much of the dumping area consisted of reef flats of one to three foot depths. Some additional information about these Keehi reef flats is relevant here.

The area was high in natural nutrient supplies from runoff and offshore sources. It was part of one of the two largest and

most productive shallow water sanctuary grounds in Hawaii for pua and kahaha, small and medium sized mullet, for oio, awa and other species of market fish. The adult mullet known as amaama, and anae were the prime market fish delicacy in Hawaii at the time of Cobb's study, and would continue to be were it not for the destruction of their habitats and sanctuaries for the young, according to commercial fishermen (Kahale, Ching, Ohai et al, personal communications 1973).

Until the 1940's, Keehi Lagoon was known by Oahu fishermen as the "home grounds" for great schools of mullet that, during and after the winter spawning season, migrated along the south shore to land's end at Koko Head and populated the island's south shore reefs. Oahu net fishermen over 50 years of age remember these schools of ocean mullet which "made the waters black." A single school was comprised of many thousands of adult individuals. In the early 1940's, Keehi Lagoon reefs were heavily dredged by Dillingham--officially for PAA and military seaplane use (only 955 passengers were recorded on PAA planes to and from the mainland in 1939)--but the evidence is rather clear that the prime purpose of the dredging was to plunder the area of approximately 20 million cubic yards of coral "spoils" for commercial and industrial fill (House Document No. 379, 77th Congress, 1941) in the Damon tract and Sand Island areas, and Kewalo district for the future Ala Moana shopping center. After this dredging of Keehi reefs and sanctuaries, the mullet quickly disappeared from Oahu's south shore. These former mullet spawning events are unknown to most of today's fishermen along Oahu's south shore. The names of the fish, describing their various stages of growth--pua, kahaha, amaama and anae--have virtually disappeard, too, from today's fishermen's vocabulary.

While state fish and game laws rigorously protect mullet (from harvesting) during their December-to-February spawning season, nothing stopped the military-industrial-political complex from almost totally eliminating this prime market specie from Barber's Point to Koko Head by destroying the reef sanctuary upon which both fish and fishermen depended.

Another two miles of the Keehi Lagoon reefs are presently being destroyed, by the same dredging company (an estimated $60 million project) for the expanded airport--the reef runway project--although viable and less costly alternatives existed. The design spells probable doom for much of the remaining Keehi reefs due to a cul de sac of pollution created at the east end. The reef runway was first billed by the state as a solution to noise and overflight hazards and publicly accepted on this basis. Later it was admitted by the state that both old and new runways will be used simultaneously. The prime purpose of the reef runway is to expand the tourist industry's carrying capacity--and profits. So we see the same forces continue at work, enveloped in a new environmental rhetoric, to be sure, but underneath is the same calloused disregard for environmental, and usually, moral or political integrity.

Returning to the Keehi dumping, the evidence shows that the three companies used the public submerged lands and fishery for dumping and filling with industrial wastes. Obviously this enhanced profits. Following the dumping, the land was graded and used for storage, curing yards, fabrication plants, machinery and warehousing and some of the stolen land was even leased to other industries for additional profits.

In December and January, 1974, the dumping was brought to public attention through rather massive media coverage. Without knowing how much the public was about to learn from official records, aerial TV coverage

and other evidence of the dumping, the principal offenders claimed innocence and were joined in the attempted deception by the state transportation department director (see below). This of course made the issue all the more interesting and extended the coverage.

Following this exposure and in response to public demand, one of the three companies involved and three of its highest officers were indicted by the Oahu grand jury, after secret investigations, under eight counts of criminal conspiracy, theft and pollution associated with the long record of dumping. Subsequent to the indictments, the president of one company, Robert Robinson, was elevated to chairman of the board of the Hawaii State Chamber of Commerce. The company's first engineer, also indicted, was then a member of the pollution control committee of the General Contractors Association. The company's third engineer, also indicted, was a governor's appointee to the State Board of Paroles and Pardons (Honolulu Star Bulletin, Oct. 18, 1974). The chairman of the board of HC&D, another of the illegal dumpers, was president of the Aloha United Fund which collected $5.5 million in public funds in 1974 (was any of this distributed to unemployed fishermen?). Thus the officials were "prominent citizens."

One of the three companies, Pacific Concrete & Rock, is absentee-owned by a mainland parent firm. Hawaiian Bitumuls & Paving Co. is a subsidiary of Dillingham Corp., one of Hawaii's largest and most influential corporations. The third company, HC&D, has been prominently involved in the recent alleged theft of public domain beach sand on Molokai for which legal changes in the definition of the state's shoreline have been obligingly made.

In spite of the gravity and multiplicity of economic, political, social and environmental issues involved, the grand jury indictments against PC&R and its officers were subsequently dismissed by Circuit Court Judge Arthur S. K. Fong. Scientists' testimony had been submitted to the jury verifying that cement and petroleum products contain mercury (Siegel 1974). "Tars and asphalt products," the statement read, "are the richest sources of mercury save for mercury minerals and ore deposits." Federal findings were presented showing that mercury can be dangerous, even fatal. Photographic evidence showed the results of mercury poisoning elsewhere, and evidence presented that the extent to which mercury may have entered the food chain in this Keehi fishery was unknown. Evidence was also presented that an alarmingly high concentration of 58 ppm of mercury (maximum FDA permitted mercury level in food for human consumption is .5 ppm) in bottom sediments recently found in Ala Wai Yacht Harbor, and that the concentration increases exponentially as it moves upward through the food chain. Fong held that the photographic evidence of mercury poisoning was inflammatory and dismissed the entire case. Had this judge, the indicted corporate officials, the state and the USCE people witnessed or experienced the agony of mercury poisoning as has been extensively documented in the tragic record of Minamata (Smith 1975)—ranked as one of the world's 10 environmental horrors—they would surely not have treated the many grave questions so perfunctorily. That they did, however, strongly suggests that these individuals were systemmically alienated by their paid roles in society from both the environmental and public health questions involved.

As soon as the public exposure of the three companies was made, Robert Muller, the HC&D chairman, announced that his company had

acted legally under a 1953 permit granted by the then Harbors Board. He didn't mention the fact that he was secretary to the Harbors Board at the time while also president of HC&D. He also failed to say that territorial law required that all such licensing actions must be in compliance with federal law, and that federal law was not complied with—specifically that a federally unauthorized change had been made in the purpose and specifications of the proposed fill operation (see below).

The illegal dumping, theft of public lands and pollution were well known by officials of the state Harbors Division and U. S. Army Corps of Engineers for many years as shown in Army file photographs and filed written evidence including reports on the dumping. A still unreleased report written in the state attorney general's office and ferreted out by the press held both the state and the USCE accountable for the illegal landfill. The report also illuminates the fact that a close friendship between the chief of the Harbors Division, Melvin Lepine, and Robert Robinson, president of PC&R Co., his next door neighbor, led to the continuation of the operation on grounds that "it did no one harm."

In an unpublished taped interview (1974) with two students following the expose, Lepine described his authority and interpreted the charges against the three companies. "I run all the harbor program statewide. That consists of some six deepwater commercial ports, all the small boat harbors throughout the state and we also have jurisdiction over some beaches and shorelines." On the charges of theft of public lands, Lepine covered with the statement: "The claim is that the land has been stolen. Well, this is obviously not so. The land is still there, it's still owned by the state. Nobody's

stolen it or removed it from anyplace." Under this generous reasoning, the state needs no laws, fences, regulations, signs or other protections for its lands--they can't be alienated. He should tell that to the Hawaiian people or the American Indians.

The students questioned the wisdom of converting Keehi fishponds with their productivity of foods into industrial dumping grounds. This exchange took place:

Lepine: You've got to consider if this was a fishery what would be, well, you've got to make an impact statement really.

Student: Has there been an impact statement for this?

Lepine: No.

Student: And yet you're dumping continuous almost daily.

Lepine: Not to my knowledge.

Student: Hmm, we were out there. We saw it on TV, too.

Lepine: In the water?

Student: In the water, yes.

Lepine: What did you do about it?

Student: We came to see you.

Lepine: Come on now! You go to see the prosecutor and file a complaint.

Student: The complaint has been filed. We thought it was your job to take care of things like that.

The students questioned Lepine on the conversion of the area under state-federal permits for dredging for "mooring facilities for small boats," deemed "public purpose" under a governor's executive order No. 1458, into industrial loading and dumping areas for private profit by large corporations. A conversion of specifications after a permit has been granted is specifically prohibited under Section 9 of the

1899 Rivers and Harbors Act. This exchange occurred:

Student: Aren't you supposed to clear it with the Corps of Engineers before you issue the licenses?

Lepine: Not - we issued - well, they had a - no there's no legal requirement. There's two - between us and the state - I mean us and the federal, there's no legal - we could issue a permit for somebody to do some shore construction work. They still have to get a permit from the Corps of Engineers.

Such clear statements of policy need no interpretation.

The interview returned to the relative worth of Keehi as a fishery or industrial dump with this exchange:

Lepine: ...the Hawaiians were serfs and their offsprings were sacrificed and everything else. If you go back to living in grass shacks, just make sure you know what you're getting into...

Student: Yes, but a lot of people are getting cheated [here], in public loss of the land.

Lepine: One thing that really surprised me in Hawaiian history and I don't know if you realized it or not, they--old Hawaiians--used to practice infanticide where the children were a nuisance, they would kill them and bury them right in their house...

Student: This culture [of ours] seems to sacrifice people on freeways, in foreign wars and plane crashes.

And, he could have added, Lepine's model nation has one of the highest homicide rates in the world.

This exchange neither validates nor excuses what happened in Keehi Lagoon. But it shows that a high state official is inclined to justify law breaking, in his mind, by a neighbor and friend and professional pal, by denigrating the values, imagined or otherwise, of the victims

of that law breaking--those who seek to protect what's left of a culture and its physical resources.

Other official responses What were the responses of other agencies of the government, particularly those charged with environmental responsibilities a few years earlier as a result of the new national concerns? Back in December 1970, at the time of passage of the federal Environmental Policy Act (NEPA), a task force was named by Gov. Burns to probe pollution of Keehi Lagoon. Head of the task force was Dr. Alvin F. Meyer Jr., White House consultant on environmental affairs and then chairman of Burns "environmental advisory hui [group]." Meyer was also legislative director for the Environmental Health Services of the U. S. Public Health Service.

The task force involved the services of environmental health specialists, sanitarians, an environmental engineer, representatives of the State Department of Health, the attorney general's office, the University of Hawaii Environmental Center, the office of the State Marine Affairs Coordinator along with county agencies. The task force was established to "deal with the problem of ocean pollution and specifically with Keehi Lagoon" (Honolulu Star Bulletin, December 22, 1970). Some relevant studies cited in the final report of the task force to the governor were the comprehensive Oahu Water Quality Program, Reef Runway studies and Technical Report Number 31 of the Water Resources Research Center, University of Hawaii, dealing with estuarine pollution in Hawaii.

This glittering array of highly paid officialdom conducted its "study" of pollution of Keehi Lagoon and filed its report. What was said about the flagrant and outrageous theft, or if you wish, conversion of public lands which contributed gross pollution to Keehi Lagoon from

both liquid and solid cement and petro-chemical products, ongoing at the time of the "study"? And what may have been said about the illegal filling of this vast acreage of prime shoreline property in an ancient and still productive fishery, its effect on adjacent public parks at Keehi and Sand Island, its alteration of circulation patterns and general water quality?

Not a word of any of this was mentioned in the report by this auspicious panel.

A few weeks after the expose of illegal dumping, Hawaii's most prestigious environmental statement emerged from a legislatively mandated Commission on Statewide Environmental Planning (Nov. 6, 1973). It would be easier to list the important people not on the commission than those who signed the report as members--legislators, a newspaper editor, councilmen, planners, high state officials including heads of state departments, federal officials and a nationally prominent Harvard consultant. This plan was intended as the matrix from which would emerge legislation and "a conservation ethic to treat our environment in the traditional Hawaiian 'spirit of malama' for mutually beneficial results" as chairman Adam A. Smyser wrote to the governor. Yet one may search in vain in this document for a single definitive word, let alone the needed detailed scientific assessment, of the condition and direction of change of Hawaii's key shoreline environment in this time in history. Of vague generalities in the document there is a surfeit which of course effectively, occasionally poetically, covers up festering and blooming realities such as the plunder and destruction of Keehi Lagoon. The foundation of the scientific method is the fullest possible identification and description of any condition prior to drawing conclusions. Thus, any concerned person, even scholar,

only with difficulty could avoid the fact that this high-powered commission acted unscientifically, indeed in a flaccid and powerless manner, in its failure to take stock of the reality of Oahu's polluted and deformed south shore.

The commission therefor produced a groundless political document. That it was also toothless, suggests that it was intended as eyewash to the concerned public in this period of environmental decline, something to talk about for a few weeks then put on the shelf.

Having testified extensively before members of this commission in various other circumstances, presenting data and photographic evidence dealing with the state's shoreline, this writer cannot avoid the feeling that, again, the paid roles in society of these individuals strongly tend to curb any prolonged concerns or meaningful actions in an area from which most of them--professionals, businessmen and politicians--have been long alienated. To put it another way, the commissions, boards, task forces and administrators who control the destiny of the Keehi fishery never included any Keehi fishermen, only those who countenanced others taking something away from them and/or cover up the fact of it. Thus were present and future fishermen, for all time, as users, alienated from the environment, along with the consumers of their catch. And in the same process, authority, or control was alienated from the prior users. Moreover, for those scholars who, to remain on good terms with those who hand out grants, went along or continue to go along with the gang, laid or lay aside the scientific method of facts first and a full honest presentation, we can say that they, and their reports, show the extent and the manner in which expertise becomes alienated from authority.

The complicity of the U. S. Army Corps of Engineers in the quarter century of illegal dumping is established in photos and documents hidden away in the Corps' files. The Corps knew about the dumping, makes regular photo surveys of the urban shorelines; they recently made silly little attempts to dissuade the companies from further violations. But the Corps ignored the fact that the three companies went right on doing so. Nineteen months after the expose, many of us here received complementary copies of a new Corps document entitled "Hawaii Water Resources Development" (January 1975). Col. F. M. Pender, district engineer, introduced the booklet saying that it describes "...how we have been assisting the State and County governments in the management and development of Hawaii's water resources." Not a word is mentioned about the Corps' mismanagement of Keehi resources under federal law.

An otherwise useful document entitled "Spheres of Influence in Hawaii's Coastal Zone, Vol. 1, Federal Agency Involvement (Rutka and Gopalakrishnan 1973) reviews the Corps' (among others') jurisdiction in Hawaii including its statutory responsibility to prevent violation of the 1899 Refuse Act which makes it unlawful to "throw, discharge, or deposit, or cause, suffer, or procure to be thrown, discharged or deposited...any refuse matter of any kind or description into any navigable water..." but makes no mention of the long ongoing Keehi dumping. Failure to mention the seamy side of the Corps' regulatory functions, as well as its numerous design failures (Kelly 1973), keeps a true picture of the Corps out of focus which ultimately shows up in the environmental debit column.

In 1971, the State Department of Planning and Economic Development

published "Hawaii and Aquaculture: The Blue Revolution," a booklet which the State Marine Affairs Coordinator, John P. Craven introduces with this comforting prose: "Aquaculture, as a vital addition to the world's food supply, also carries the responsibilities for protection of the seas and the coastal areas--rather like soil conservation on land. This is doubly true when one considers the fantastic yield per acre possible from the seas." The booklet approvingly pictures Cook Islanders building dikes by hand for mullet ponds and describes "...the Pacific islands...as a first priority [for aquaculture development] because of the availability of lagoons, of a wide variety of species--especially the plant and filter feeding types--and of warm, sunlit conditions." Such poetic fantasy belongs on the shelves of literary fables--it has nothing to do with the reality of the loss to an alienating market economy of over 200 painstakingly built Hawaiian fishponds of which only one or two remain in operation.

The booklet contains not a word of the former "fantastic yield" of fish, especially mullet, that has been destroyed with the dredging and filling of the 18 Keehi fishponds in recent years in Hawaii's most "warm, sunlit" and, he might have added, formerly one of the largest and most productive lagoons in the Pacific.

The 1974 edition of "Hawaii and the Sea" (DPED) prepared for the governor's Advisory Committee on Science and Technology also fails to mention the major debit of the loss of Keehi Lagoon as a principal fishery of Hawaii and the reasons therefor. The 1969 edition of this work, subtitled "A Plan for State Action" presents the data cited earlier that show what can only be described as a catastrophic

drop of over 50 percent in the local per capita consumption of fresh fish in the 20 years to 1968, while demand was continually rising. There is no doubt that a significant part of this drop resulted from the government authorized destruction of the Keehi fisheries by dredging and filling, as well as the unauthorized dumping and filling by the three construction companies under discussion. This report's recommendation: "The State should continue its activities in aquaculture, especially the development of facilities and techniques in rearing fish and shellfish."

The public cost of subsidizing such reports, of aquaculture studies and the simultaneous destruction of centuries old aquaculture sites and proven knowledge remains to be rationalized both in dollar figures and in logic.

One more significant planning study is worthy of mention. It is the 1968 Honolulu Harbor planning study conducted for the State of Hawaii by Wilson, Okamoto et al. This document is filled with maps, charts, aerial photogrphs and proposed plans for the further development of Honolulu Harbor and adjacent Keehi Lagoon waters. Land use identifications of the properties occupied by the three offending companies are included. The consultant's list of firms and persons interviewed for proposed uses of the Keehi and Honolulu Harbor shorelines reads as a who's who of Hawaii's most prominent public and private agencies and firms. This report also contains no word of the then 15-year old record of criminal conversion of public resources and private re-shaping of the Keehi Lagoon shoreline. Several maps show the shoreline, not as it actually was in 1968 but apparently as it was assumed to be.

This list of blind documents could go on but we will end it here and move to the subject of how the Keehi Lagoon dumping, so long unseen, ignored and covered up, was actually brought to light.

For the 1973 Surf Parameters study, this writer had made a superficial survey from various documents (as we have just shown, conclusions drawn from all document surveys risk being superficial) of the 9-mile segment of the state's most urbanized shoreline from the international airport to Waikiki. This survey which included the USCE's log of permits for supposedly all shoreline interventions in Hawaii since 1903 (many pass by undetected by the desk-bound Corps) showed that not a foot of this 9-mile segment remained in its natural condition. Most of the alterations occurred in recent decades, nearly one-third were from dredging and filling and many of the major dredging and filling projects involved Dillingham Corp. All required federal and territorial or state sanction and all the significant projects involved public funds for all or part of the expenditures. It would not be difficult to show that the prime beneficiaries of these "reclamations" were in the private sector.

Although quite familiar with this area in which a number of us in SOS had grown up as fishermen and surfers, we thought it would be worth a fresh and closer look--than through the closed eyes of writers of government reports--at what urbanization and profit seeking does to some of the inshore marine systems.

So on Oct. 8, 1973, two of us, armed with b & w and color film, began a photo-walk at Hickam AFB along the water's edge. You will see in the slide presentation accompanying this paper some of what we found.

This simple walk on foot, with our eyes as the only tools of observation, and cameras to record what we saw, brought to light Hawaii's most flagrant case of illegal shoreline pilferage and pollution. A brief check with the USCE log of permits and a few other accessible documents such as the wording of the 1899 Refuse Act--perhaps a total of a couple of days work--established clearly that gross private plunder of public resources had been and continued to be underway (our photos show actual cement dumping in action) with the knowing complicity of government agencies statutorily responsible to prevent such things. The Towill photos, as we said, showed the land accretion had been going on for approximately a quarter century. We believe that this case only brought the tip of the iceberg into view--the record of perhaps less clumsy but equally insidious plunder of public shoreline resources for private profit is known by many but remains to be brought to light.

As the record shows, no official or government agency acted with vigor before or even after the expose. Among points made in a Honolulu Advertiser editorial (Aug. 13, 1974) were that Molokai sandmining and Keehi landfill operations demonstrate the "need for greater State surveillance," the State was less than vigorous in remedial action, the attorney general admitted "failure to move diligently" and "the most distressing aspect was ommission of pertinent findings by Transportation director E. Alvey Wright when he released a summary of the investigation." The paper stated that "There is little justification...for more than a decade to lapse before the State finally took action against illegal dumping of which it should have been aware, but which environmental groups had to bring to public attention before the State stepped in."

Only intense public exposure of these violations via the media brought cessation of the dumping. But no significant legal action against the violators or their cousins in government who covered up for them for so long has been achieved for redress of public grievances or compensation for loss of public resources. Moreover, the media only focussed on the violations of law. These illegalities, by the way, could have been avoided in the early 1950's by DOT and its corporate friends merely getting the governor to amend a prior executive order and brushing up a few permits, all well within the usual practices of government.

What the media, government officials and agencies have systemmatically ignored and failed to comment upon is the larger issue, the folly of destroying irreplaceable natural shoreline resources. The unique combination of estuarian resources, with their complex eco-regimes of interlocking nutrition supplies, species diversities and supporting physical systems such as tide, wave and thermal-induced water circulation are not replaceable by man. By destroying them for short range purposes, such as corporate profits of benefit only to an elite few, alternative uses of nature have been eliminated forever. What took centuries or even millenia to develop has been destroyed by these few and placed beyond recovery by mankind. Still further, beyond the issue of ecocide, is the emerging and politically explosive question of cultural genocide being committed against the remaining heritage, resources and associated lifestyles of the Hawaiian people and those who share it with them.

The highest public official to comment on the illegal dumping, Adm. E. Alvey Wright, state transportation department head, first announced immediately after the expose, that the public was the

offender, not the victim, of this outrage. The public, he said, was responsible for the dumping (DOT news release, Jan. 8, 1974; Honolulu Star Bulletin, Jan. 19, 1974)--of tons of bitumul road topping next to Dillingham's bitumuls plant, of acres of HC&D-dated cement slabs, cement tailings and other cement products next to two corporate cement fabricators covering an area amost half as large as Ala Moana Park! To the crime of private theft of public domain, add that of gross public deception by the companies and high government officials to coverup the private gain. Hawaii's watergators, it seems, thrive in the murky depths of public deception, for, with the exception of the secret AG's report, not one public official in this case, as far as we know, has so much as been chastised by any government authority from the appointing governor on down.

Dishonesty at the top did not extend to the workers employed by the dumping companies. This writer held conversations with a number of bitumuls truck drivers, cement workers and other on-site employees of the three firms before and after public disclosure of the illegal dumping. Some of them were personally involved in the dumping as equipment operators. They openly stated that they had been involved, that the orders to dump had come from their bosses, and that it had been going on for years. Some of the workers said they personally knew fishermen in the area as friends, or formerly fished there themselves, and felt bad about what was happening to the mullet grounds, but said they couldn't say anything about the dumping in the past for fear of losing their jobs. Any worker that risked a $10,000 per violation fine against his employer would

clearly be another dispensable item by his boss, regardless of the morality or environmental issues involved, or probably, of union contract provisions.

After public disclosure, according to some workers, the companies apparently passed "word" to their employees not to talk about the matter to anyone other than the corporation attorney, an interesting attempt to suspend the workers' free speech rights. The workers said they were led to believe that they, not the company, were liable to punishment for the dumping.

On Christmas day, about two months after the initial discovery, this writer held a conversation at the dumping site with the proprietor of a small company that leased land at the dumping site. He, too, described the frequent dumping ("They been doing it for years!"), pointed to the vehicles used including the familiar orange and black cement truck "barrels" some of which were discarded with the other industrial wastes in the Keehi waters.

For the purpose of our discussion of alienation here, the disavowment of guilt by the company heads and the readiness of the workers to admit the obvious truth of the matter is significant. The dishonesty prevailed at the top where legal and financial "responsibility" is fixed. These are the agents of parent companies, bankers and absentee owners who transmit the competitive pressures of the market economy through the chain of corporate links. Usually, they do not see the operation of companies they partially own and direct.

Thus the authority of the system is alienated from the wholeness of the natural environment with its own interacting processes. Even if environmental concerns are sincere on the part of an individual corporate head, where conflict may exist between corporate and

environmental interests, the latter are clearly pre-empted by the former for reasons of corporate survival, so precarious are the relations within the competitive system.

The same may be said of the political agents of the system whose structural role alienates them for the most part from the environment, as well as from the economics of the system, and today, from much of the electorate. Needless to say, no politician of the Kalihi district where the violations occurred over that long period of time had ever made an issue of the matter. One state senator from Kalihi known for his liberal views, was invited to the press conference at which the first public revelation of the dumping was made. He failed to show up. Not one of the fifteen members of the House Environmental Committee, or the corresponding senate committee members, or for that matter of the entire 76-member legislature has publicly shown any interest in the case to the best of our information.

Again, while fear of disclosure and punishment did not prevent the dumping for all those years, once the dumping was widely publicized it was not responsibility but fear of further exposure that motivated the parts of the system, each in its awkward, limited and alienated fashion. A deputy state attorney general conducting the investigation stated to this writer that the dumping was forgivable in his opinion because at the time it began and for many of the subsequent years there was little environmental consciousness or legal concern. It was rather obvious that his remarks reflected thinking of higher authority. Apparently the 1899 Refuse Act meant as little to this official as did the two millenia during which an environmentally sound and productive Keehi Lagoon supported all those surrounding

villages and dense population.

The scope of this paper does not permit examination of the relationships between Hawaii's largest marine-oriented construction firm and the two cement fabricators with the government agency that handles most of the state's public contracts under which bitumuls and cement products are used--the Department of Transportation (harbors, airports and highways)--and the dependency of the political parties on large campaign funds from the corporations effectuated through salaries of individual executives, birthday dinners and the like. Mention of the fact should suffice to suggest answers as to why the Keehi dumping was allowed to go on "undetected" for so long, and the reticence on the part of the state to fully investigate and expose the reasons, of for that matter, the courts and prosecutor to act expeditiously and efficiently. On the latter point, the public prosecutor, rather than assigning a top flight deputy, as demanded, to investigate the circumstances of this important case, counsel grand jury witnesses and secure a watertight indictment, put two unlicensed, overworked and inexperienced undergraduate law clerks to work on the matter. The court's action in dismissing the case was partly based on the methods they used in preparing the inquest. Was this failure to act as needed sheer incompetency, or a setup, a planned escape route for the accused? At this point it is difficult to say--the line between natural and intentional incompetence, while significant, is often hard to distinguish.

It would appear that objectivity in this situation on the part of any government agency is not to be expected. Let all officials relax in comfort whose fears may have been aroused by the prospect of serious investigation. Two years have gone by--"oly-oly-oxen-free!"

Alienation has clearly advanced in all three categories--of users from the environment, of authority from users and of expertise from authority--to the degree that things will not change basically, at least not between the principal structural agencies involved.

As we said at the beginning, included in the definition of alienation is the act of selling, of separating a thing from its producer or even owner. If we generalize the act of selling of the products of both physical and mental labor, we describe the essense of the market or capitalist system. Herein lies the character of the trashing society, the composite result of making or using things primarily for sale, including parts of the environment, rather than for their use value (Marx 1967:vol.I:35). The ultimate expression of this process is the alienation of man from himself, in the name of freedom, a slave of the market (Caudwell 1938).

Let us now briefly look at some of the features of the Hawaiian subsistence system with its localized and integrated cycle of production and consumption and the relation of this mode of production to the natural environment.

Hawaiian subsistence economy In pre-1778 Hawaii, a large population lived totally within the local environmental sphere--except for natural things like waves and sunlight and wind, nothing manmade entered or left the island economy. It was totally recycling.

Food production, storage and consumption was localized. Without refrigeration or the need for it, food was kept fresh and alive in the ground, on the trees and in the waters until needed. Due to the local character of production and consumption, most food supplies and habitation sites were never far apart.

A basic natural division of resources existed between upland and shoreline areas. Protein foods--fish and marine fauna--predominated along the shorelines. Carbohydrates were cultivated in lowland, midland and upland districts according to the availability of fresh water. The exchange of these complementary foods was accomplished by the production of a small exchangeable surplus that was distributed in short range travel between inland and shoreline districts (Kelly 1969). Probably a minimal, if any, exchange took place between river valleys or shoreline districts and their counterparts elsewhere since similar resources prevailed among them.

Shoreline dwellers left their villages for periods of time in the mountain districts where timber and tool making resources were available. The conversion of natural resources into products suitable for use involved some modifications of nature. Streams were diverted into extensive irrigation systems. Tidal pools, estuaries, rivers and reefs were partially enclosed into highly productive fishponds. Portions of midlands and uplands were cleared, cultivated and irrigated for gardens of taro, sweet potato and other carbohydrates. Materials used for construction, tool making and apparel were cultivated, harvested or mined and relocated for considerable distances for the making of houses, canoes, surfboards, and equipment shelters, utensils, tools and recreational equipment (Malo 1951:127).

When we look at evidences of these modifications of nature by the Hawaiians, we see that except for the mining of toolmaking stone, they resulted in the heightened renewability of local resources. Fishponds increased the local fish supply. Horticulture increased the productivity of local soils. Irrigation raised the fertility of surrounding local lands. The Hawaiian upland-lowland water control

system retained soil nutrients in the highlands, effectuated lowland flood control, increased the diversity of species in the localities where they were developed and extended that diversity into formerly less productive areas. The greater durability of eco-systems with diversity of species is well established, just as it is equally known that specialization of species tends to weaken communities.

What was the effect on the state of knowledge of the people of this localized environmental dependency? One of the striking effects was that Hawaiian society developed a very high level of environmental awareness, the malama or conservation ethic. We have mentioned above the reflection of this awareness in the language of the people, permanent words in the vocabulary that describe subtle differences in the stages of growth of plants, animals, conditions of nature, climate, currents, waves, winds and much more. This information was not kept alive in textbooks, for they needed none, but in the daily contact that the people had with their natural environment.

The local character of production and consumption--of the expenditure of labor and the realization of its benefits--also tended to minimize waste. Thus a natural built-in regulating factor limited or prevented damage to the environment or wasteful practices, or needless over-harvesting. To this day, Hawaiian fishermen follow this ethic when they purposefully avoid taking an entire school of fish, or put some back "for the future" or for the akua, the god or spirit of that specie or of the sea.

Summary

Three large industrial companies were caught in a flagrant case of illegal and environmentally harmful dumping in publicly owned shoreline waters.

Federal and state agencies including a court are shown to have been inert in preventing the emasculation of resources and law breaking over a quarter century and inept at redressing public grievances.

Fear rather than responsibility motivated a jerky bureaucratic response on the part of officials following public disclosure.

A pyramidal shaped power structure with one-way top down authority inhibits responsibility at all levels to other than survival of corporate interests in a grab all world of competition and self concern.

All three stages of alienation--of users from the environment, of authority from users and of expertise from authority--arise from the corporate-political market system characterized by private absentee ownership of the means of social production.

Ultimate controls over the companies are buried remotely within an amorphous financial system distant from the scene of production and, in this case, of environmental degradation.

Consumers of the products of the dumping companies are likewise physically alienated from the process of production and oblivious to the methods and consequences of the system of production.

By way of contrast, we have shown how environmental awareness developed within the locally oriented Hawaiian subsistence economy of pre-capitalist Hawaii. The communal system was totally self

sufficient requiring regenerative rather than exhaustive use of natural resources. Survival safeguards tended to enhance the physical conditions of the islands.

Of two civilizations that consecutively occupied the same closed island space with approximately the same populations, the means of production to fill social needs were communally regulated in the former, are privately owned in the latter.

After nearly 2000 years of occupation of the islands, the Hawaiian communal system was found to be flourishing within the limits of its technology.

After 200 years of occupation of the islands, the market system of private ownership of the means of production has become almost totally dependent on imported things and values, views the environment as an object of exhaustive exploitation for private gain to the limit of its technology.

In the Hawaiian civilization, human society and nature were seen as parts of a whole, hence understanding and deference to natural laws prevailed.

In the market economy of production for private gain, natural laws are obscure, manmade laws an abstraction against which the anarchy of competition prevails.

The dependent alienated society annihilated the self sufficient society and continues to destroy its remnant resources and values.

A NOTE:

The elucidation of the origins of alienation in the present society and comparison with the social system which the present one destroyed is historically valid for the purpose of understanding reality. No suggestion is being advanced here that society can or should return to a pre-industrial stage of social organization. However romantic, the notion is not a real option.

What is real is the crisis of contemporary events which move on inexorably to fundamental change. The essential conflict is not between past and present, but between present and future.

This paper is dedicated to those who seek to face that future with honesty.

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